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Mussard, D.E.]

Technical Note
(USFS Research Agreement 38-K4-341)
[28]

A DESCRIPTION OF THE POLLUTION POTENTIAL INDEX OF THE TAPAS TWO-DIMENSIONAL WINDS MODEL

Prepared for

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June 15, 1985

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1.0 INTRODUCTION

The National Environmental Policy Act (NEPA) and the Bureau of Land Management's planning regulations, under the Federal Land Policy and Management Act (FLPMA) require the public evaluation and consideration of proposed land use planning alternatives. The potential air resource related impacts associated with land use planning alternatives are normally evaluated along with impacts to other resources. One method of assessing the potential air resource impacts is with the pollution potential index developed for the WINDS model of the TOPOGRAPHIC AIR POLLUTION ANALYSIS SYSTEM (TAPAS).

A pollution potential analysis provides a general indication of geographical areas where air pollution problems would be more likely to occur if nearby pollution sources existed. Pollution potential index maps can be used to support land use planning decisions including consideration of potential air quality impacts.

This technical note describes the air pollution potential index applied in the TAPAS WINDS model, details the index assumptions and presents the results of pollution potential index analyses for two areas in southwestern Wyoming.

The research and analyses presented in this report were performed for and funded by the Bureau of Land Management and the Forest Service Rocky Mountain Forest and Range Experiment Station under Forest Service research contract 28-K4-341.

2.0 POLLUTION POTENTIAL INDEX ANALYSES

2.1 The Pollution Potential Index Calculation

The pollution potential index is calculated as a WINDS model option within the Topographic Air Pollution Analysis System (TAPAS) (Fox et. al. 1983). The index is a function of the wind speed and the Gaussian dispersion coefficients under stable conditions (class E-stability). The index (I_p) is defined as:

$$I_p = \frac{X}{Q} = \frac{1}{\pi \sigma_y \sigma_z} (1 \text{ X } 10^6)$$

where X = ground level concentration in $\mu g/m^3$

Q = pollution source strength; assumed to be 1 g/s

σ_y = horizontal dispersion coefficient assuming E-stability and a source to receptor distance of 1000m;

$\sigma_y = 0.096\ (1000)^{0.9} = 48.114$

σ_z = vertical dispersion coefficient assuming E-stability and a source to receptor distance of 1000m;

$\sigma_z = 0.85\ (1000)^{0.47} = 21.848$

U = wind speed (m/s) for a grid point, based on results from the grid based diagnostic wind model WINDS. All wind speeds less than 0.5 m/s are assumed to be equal to 0.5 m/s.

The pollution potential index is based on the observation that pollution accumulates more readily in protected areas characterized by low wind speeds than in well exposed areas that experience stronger winds. Thus, a higher pollution potential index would be calculated for the low wind speed area. Class E-stability assumptions represent realistic worst case conditions. A 1000m source receptor distance was selected because it is representative of the general distance between grid points used in the most common applications of the WINDS model.

2.2 Interpretation of the Index

The index is calculated, and should generally be interpreted, to represent estimated ranges of pollution potential. Figure 2-1 is a plot of

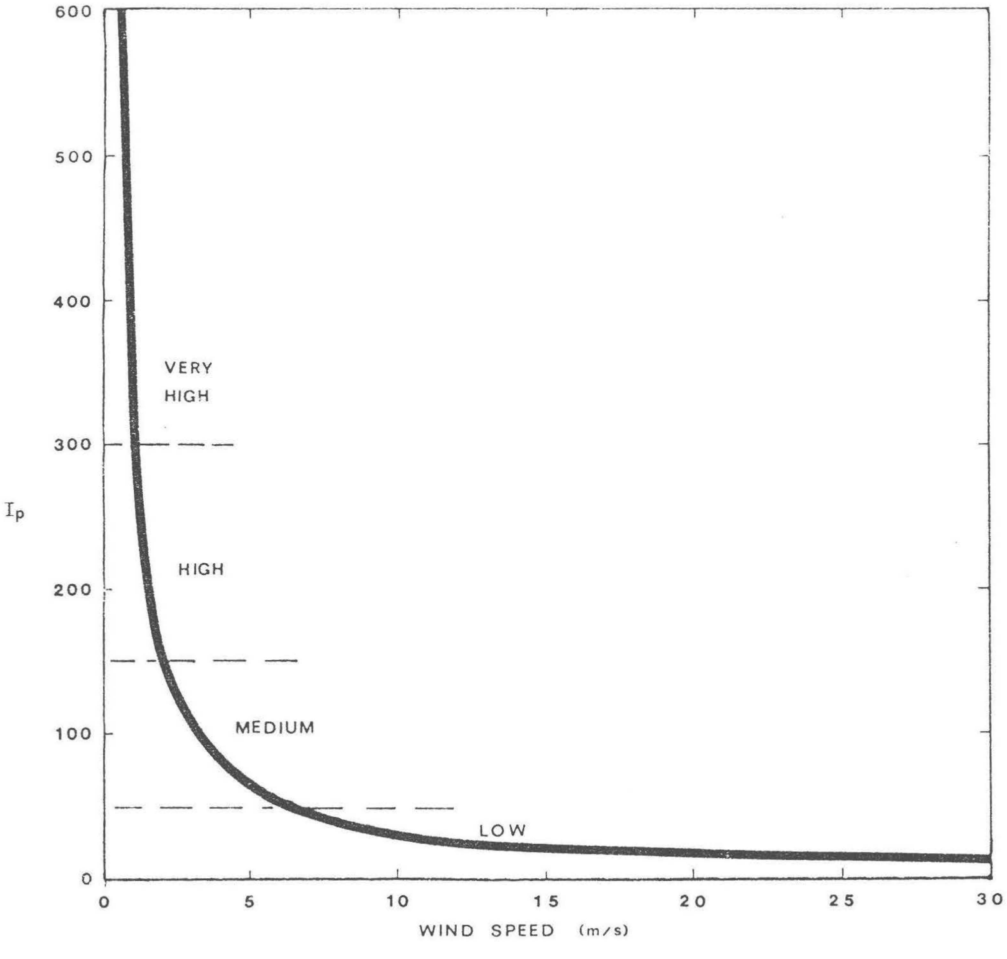


Figure 2-1. Pollution Potential Index (Ip) Values for a Range of Wind Speeds (meters/second).

index values over a range of wind speeds. The index varies from 0 to 606 (0.5 to 30+ m/s).

Index values are generally reported in one of four ranges:

Pollution Potential Index Values	Verbal Description
<50	low
50-150	medium
150-300	high
300>	very high

The index value can, however, be interpreted quantitatively under E-stability conditions. Because a 1 g/s ground level source strength is assumed in the calculation of the index, the index value can be multiplied by a known emission strength from a specific ground level source to estimate the ground level concentration (in $\mu g/m^3$) 1000m down wind of the specific source. For example, if the calculated index for a grid point was 20 and a planned nearby source (within 1000m of the grid point) was projected to release 15 g/s of particulate matter (TSP) at ground level, the projected impact under class E-stability conditions would be calculated as: $(20) \times (15) = 300\ \mu g/m^3$.

To interpret the index for emissions from an elevated source, the index value can be roughly adjusted by a plume rise multiplier. To calculate the multiplier (Mpr):

$$M_{pr} = \exp\left[-\frac{1}{\sigma_z}\left(\frac{H}{\sigma_z}\right)^2\right]$$

where H = effective plume height in meters (up to 80 meters)
σ_z = vertical dispersion coefficient; assuming E stability and a source receptor distance of 1000m ($\sigma_z = 21.848$)

Figure 2-2 presents a plot of plume rise pollution potential index multiplier (M_{pr}) values over a range of effective plume heights (H).

The pollution potential index value can be adjusted by the plume rise multiplier (Mpr) for a specific source assuming E-stability conditions.

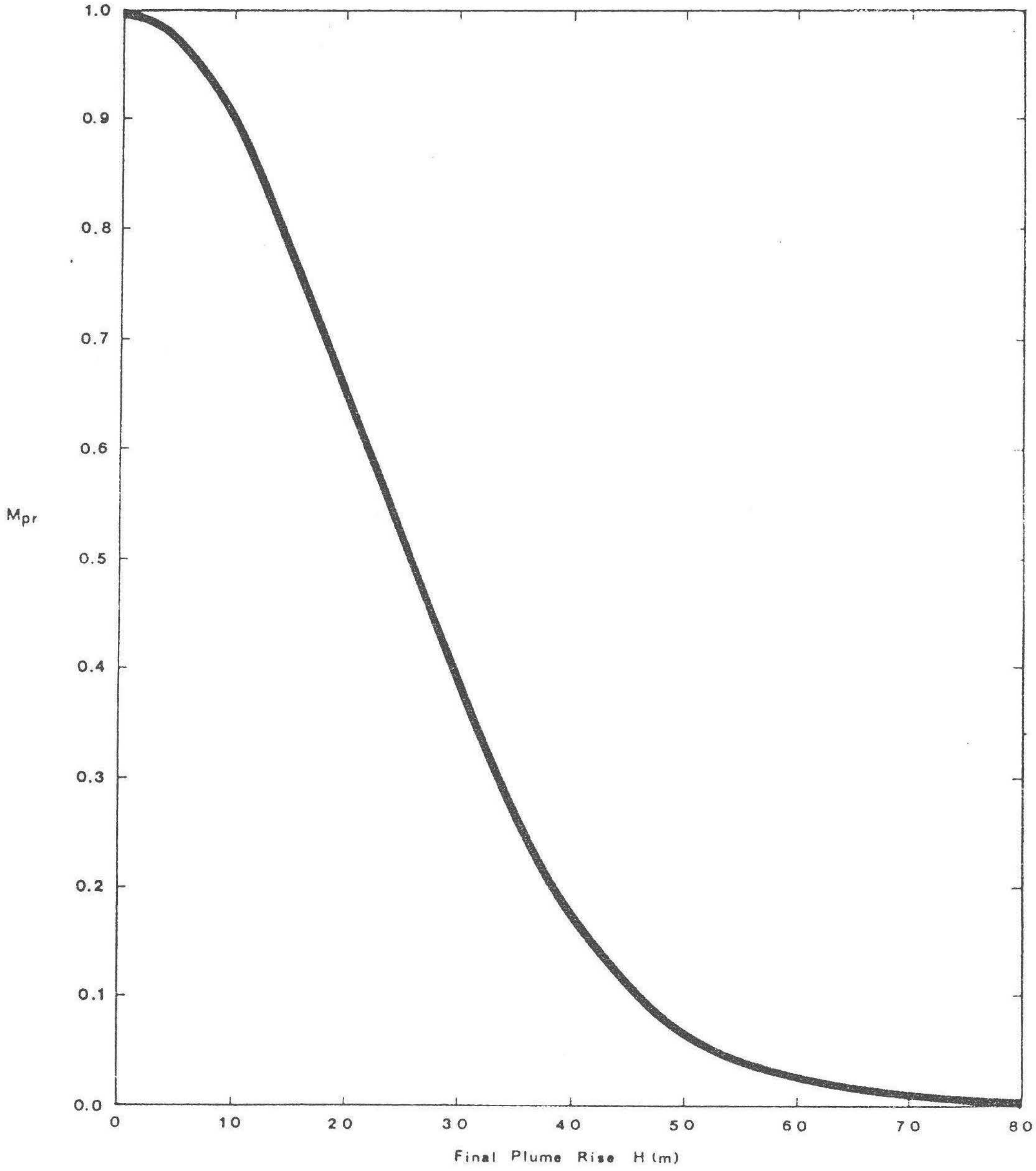


Figure 2-2. Plume Rise Pollution Potential Index Multiplier (M_{pr}) Versus Final Plume Rise Height (H) Assuming E-Stability Conditions.

For example, if the calculated index for a grid point was 20 and the final plume rise was calculated as 20m ($M_{pr} = 0.658$), then the projected impact at 1000m from a source emitting 1 g/s would be calculated as (20)x(0.658) = 13.16 $\mu g/m^3$.

2.3 Annual Pollution Potential Index Analysis

Annual pollution potential index analyses are often performed to provide an overview of potential air quality problem areas in a selected study area based on annual wind frequency data. Pollution potential calculations for individual wind fields over a selected study area can be combined by considering the frequency of occurrence of each modeled wind condition (based on a stability windrose) to yield an annual pollution potential contour map. This analysis is performed by:

1. Selecting a study area of interest (represented by a geographic X-Y grid).
2. Selecting a representative annual stability/wind frequency distribution table for a study area. The frequency distribution is generally reduced to sixteen wind directions, six wind speeds and six stability classes.
3. Performing a TAPAS WINDS model and pollution potential index analysis for each wind speed, direction and stability class. Each analysis will yield a pollution potential index value for every grid point in the study area.
4. Combining the index results from each of the model runs into a composit annual pollution potential index grid. The final index from each model run is then weighed by the frequency of occurrence of each wind speed, direction and stability class.
5. Performing a contour analysis of the resulting annual pollution potential grid.

The wind frequency distributions for a study area can be selected to represent conditions under specific stabilities or under all conditions. Often, individual annual pollution potential index analyses are performed for several stability wind frequency distributions to provide a range of average to potential worst case conditions. For example, individual annual pollution potential index maps for a study area might be produced to represent the pollution potential index under three conditions; all stabilities, E-stability, and F-stability.

Annual pollution potential analysis maps can provide general guidance in planning for a wide range of land uses. Planners may wish to avoid development of pollution sources within or directly upwind of high pollution potential areas. Overlaying maps of pollution potential with other resource maps may also provide the planner with a unique way to consider the air resource along with more conventional resources (mineral, water, soils, vegetation) in a comprehensive land management plan.

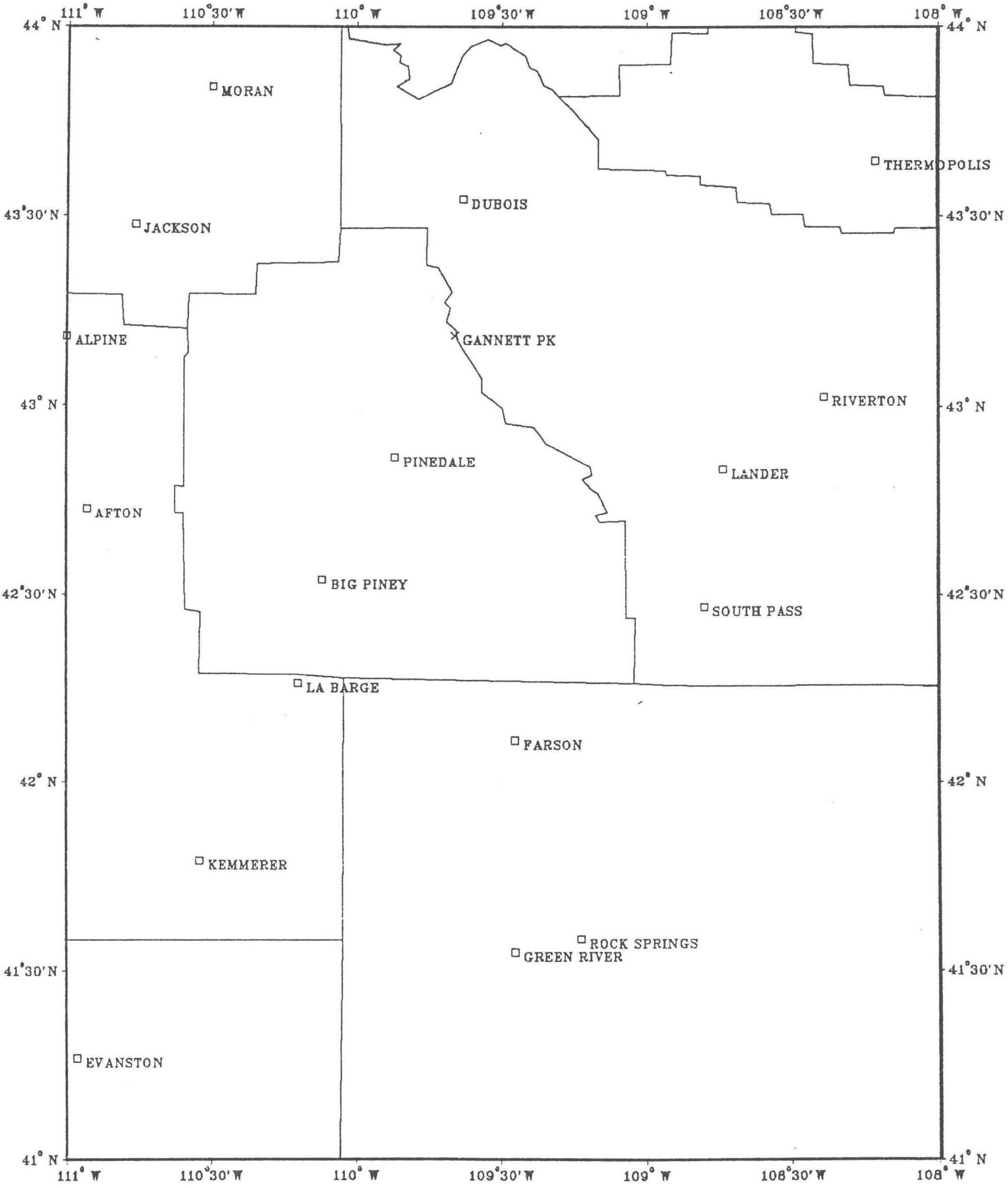
3.0 Example Pollution Potential Study

Example pollution potential analyses were performed for two areas in Southwestern Wyoming (a regional area and a site specific area). The geographic specifications for each area are detailed below.

Figure 3-1 (and Plate 1) is a base map of the southwestern Wyoming Regional Study Area. Figure 3-2 (and Plate 2) is a topographic map of the region derived from the digital terrain data used in the WINDS model/pollution potential index analyses. Table 3-1 provides the geographic specifications for the area. The regional study area selected by the BLM provides a synoptic overview of Southwest Wyoming that includes major oil and gas development areas, population centers, and important range, forest, and wilderness areas.

Figure 3-3 (and Plate 3) is a base map of the site specific Evanston Study Area. Figure 3-4 (and Plate 4) is a topographic map of the area derived from the digital terrain data used in the WINDS model/pollution potential index analyses. Table 3-2 provides the geographic specifications for the area. The Evanston Study Area selected by the BLM exemplifies a specific area where oil and gas development is planned.

Annual pollution potential index (PPI) maps based on annual wind frequency distributions for F-stability, E-stability, and all stabilities were produced for the Southwest Wyoming Regional Study Area. F-stability and E-stability maps were produced for the Evanston Study Area. The details of the analysis assumptions and resulting pollution potential index maps are presented in the following subsections.



111° W
110°30' W
110° W
109°30' W
109° W
108°30' W
108° W
44° N
43°30' N
43° N
42°30' N
42° N
41°30' N
41° N
MORAN
THERMOPOLIS
DUBOIS
JACKSON
ALPINE
GANNETT PK
RIVERTON
PINEDALE
LANDER
AFTON
BIG PINEY
SOUTH PASS
LA BARGE
FARSON
KEMMERER
ROCK SPRINGS
GREEN RIVER
EVANSTON

Figure 3-1. Base Map of the Southwestern Wyoming Regional Study Area 3.

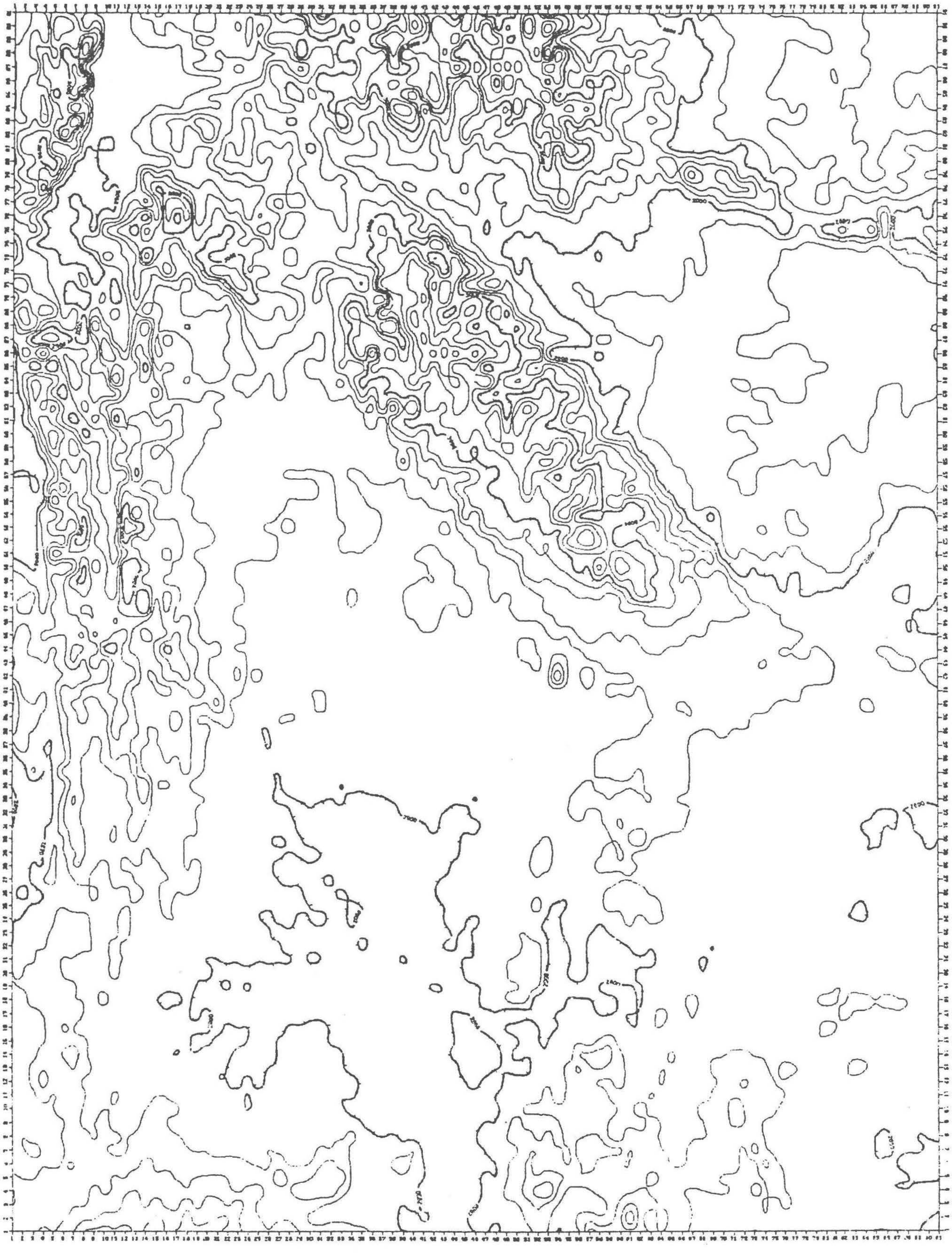


Figure 3-2. Topographic Contour Map of the Southwestern Wyoming Regional Study Area (Contour Interval = 200m).

TABLE 3-1

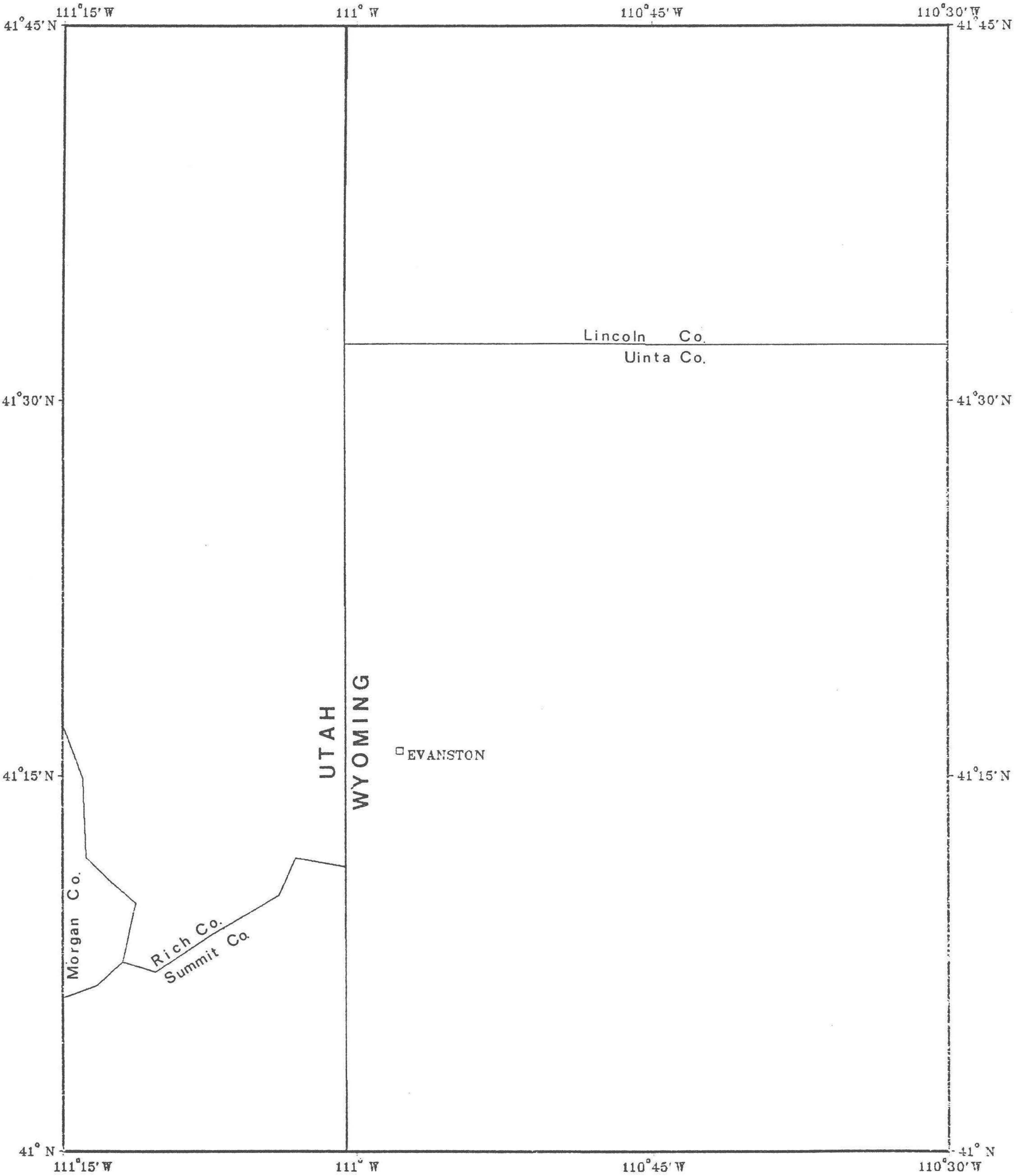
Geographic Area Specifications of Southwestern Wyoming Regional Analysis Area

S.E. Corner		N.W. Corner		No. of Grid Points		Ave. Grid Spacing			
						MINUTES		KM	
LAT.	LONG.	LAT.	LONG.	X	Y	X	Y	X	Y
41 °	108 °	44 °	111 °	91	91	2.0	2.0	2.732	3.706

TABLE 3-2

Geographic Area Specifications of Evanston Analysis Area

S.E. Corner		N.W. Corner		No. of Grid Points		Ave. Grid Spacing			
						MINUTES		KM	
LAT.	LONG.	LAT.	LONG.	X	Y	X	Y	X	Y
41°	110°30′	41°45′	111°15′	91	91	0.5	0.5	.6938	.9264



111°15'W
111° W
110°45'W
110°30'W
41°45'N
41°30'N
41°15'N
41° N
Lincoln Co.
Uinta Co.
UTAH
WYOMING
EVANSTON
Morgan Co.
Rich Co.
Summit Co.

Figure 3-3. Base Map of the Evanston Study Area

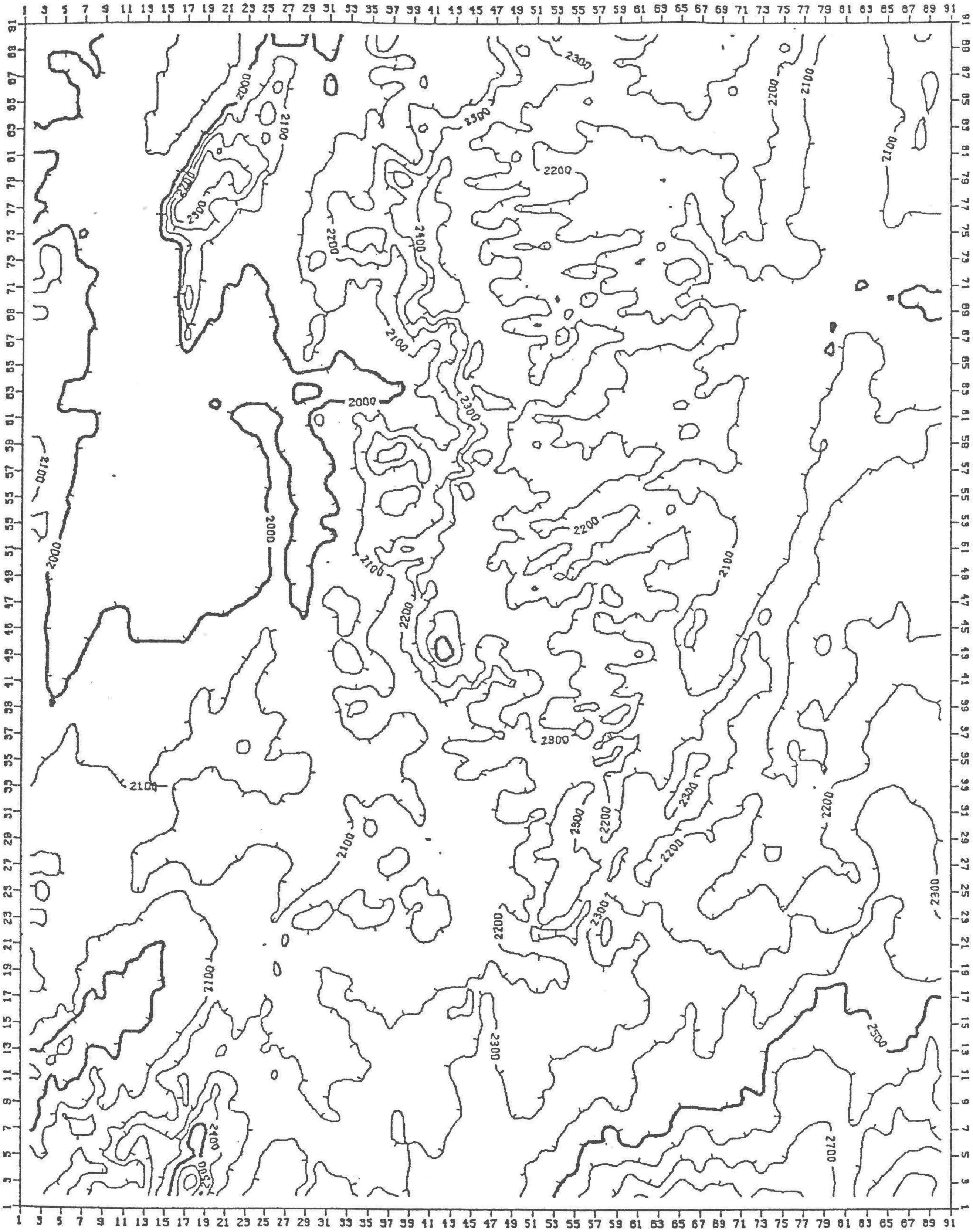

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91
2000
2100
2200
2300
2400
2500
2700

Figure 3-4. Topographic Contour Map of the Evanston Study Area (Contour Interval = 100m).

3.1 Southwest Wyoming Regional Study Area

Stability-based wind data from the Rock Springs, Wyoming weather station (NOAA 24027) provided representative wind frequency distributions for the Southwest Wyoming Regional Study Area. The wind data covered the period 1/1/67 to 12/31/71. Annual wind frequency distributions were available for A through F stabilities individually and all stability conditions combined. PPI analyses were performed for F-stability, E-stability, and the combined (all-stability) wind frequency distributions. The frequency distributions used are presented in Appendix A. Each frequency distribution is represented by sixteen wind direction classes and six wind speed classes as presented in Table 3-3.

WINDS/pollution potential modeling was performed for each of the 96 wind direction/wind speed classes for each of the three considered wind frequency distributions (F, E and all). The wind velocity vector results of the WINDS model for the most common wind under these conditions were plotted to provide a graphic overview of the wind field throughout the study area. These three plots are provided in Appendix B.

The individual PPI values from each run were proportianally combined to yield annual (stability based) PPI representations. Annual PPI contour maps were produced for F-stability, E-stability, and all-stability cases, and are provided as Figures 3-5, 3-6, and 3-7 respectively.

The PPI maps for F, E, and all-stability cases are similar. The highest pollution potential exists northeast of the Wind river range, east of the Teton Range and in the Star Valley. PPIs in the high category do occur in each modeled case with more area in the high category occurring under F and E conditions.

TABLE 3-3

Wind Direction and Wind Speed Classes Applied in the Pollution Potential Index Analysis.

Wind Direction Classes	
Class	Degrees from True North
NNE	22.5
NE	45.0
ENE	67.5
E	90.0
ESE	112.5
SE	135.0
SSE	157.5
S	180.0
SSW	202.5
SW	225.0
WSW	247.5
W	270.0
WNW	292.5
NW	315.0
NNW	337.5
N	360.0

Wind Speed Classes		
Range (KNOTS)	Range (M/S)	Representative Mid-Point (M/S)
1-3	0-1.54	1.0
4-6	2.06-3.09	2.5
7-10	3.60-5.15	4.0
11-16	5.66-8.24	7.0
17-21	8.75-10.81	9.75
21 +	10.81+	11.0

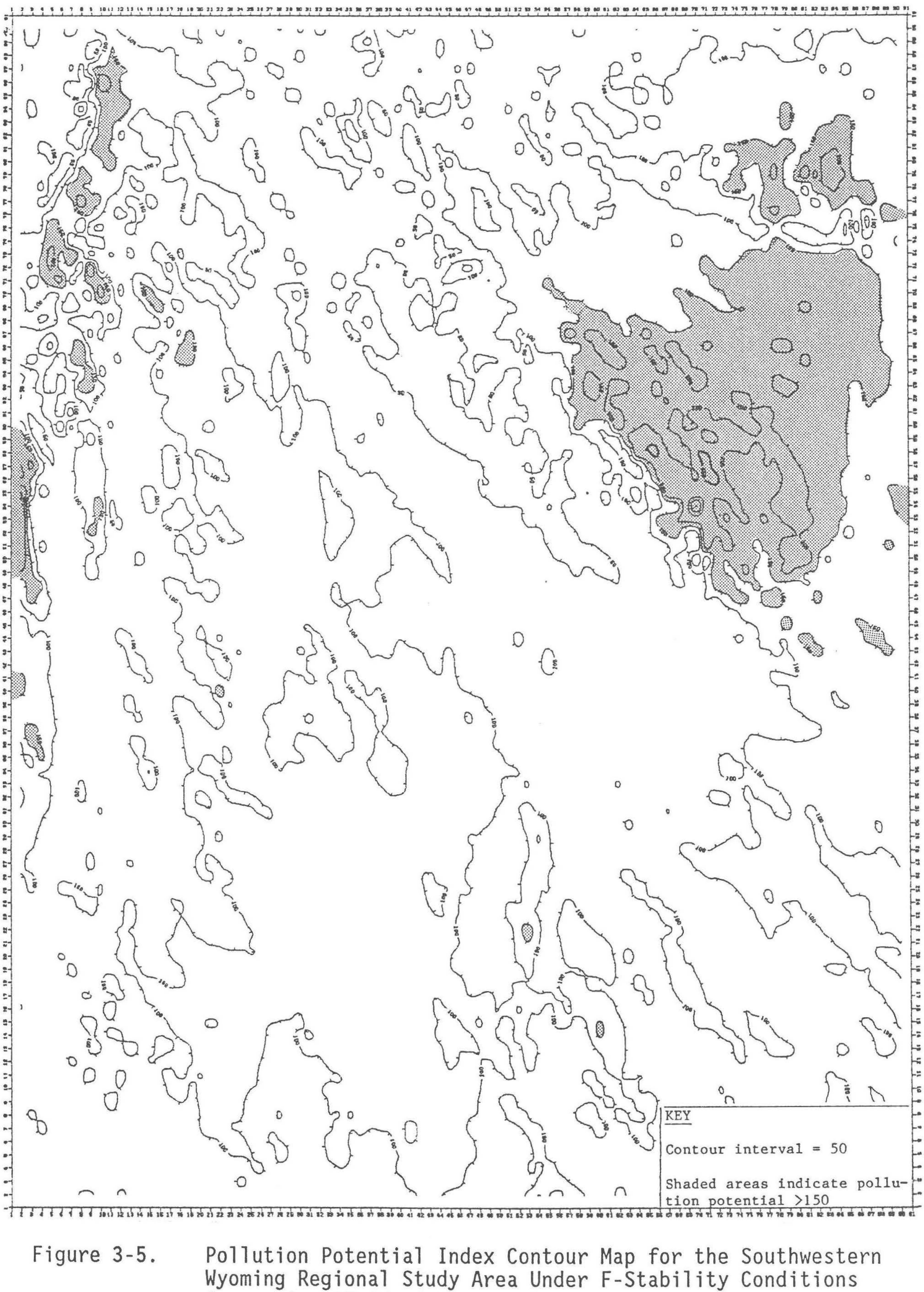

KEY
Contour interval = 50
Shaded areas indicate pollution potential >150
100
150
200
50

Figure 3-5. Pollution Potential Index Contour Map for the Southwestern Wyoming Regional Study Area Under F-Stability Conditions (occurring 17.0% of the time).

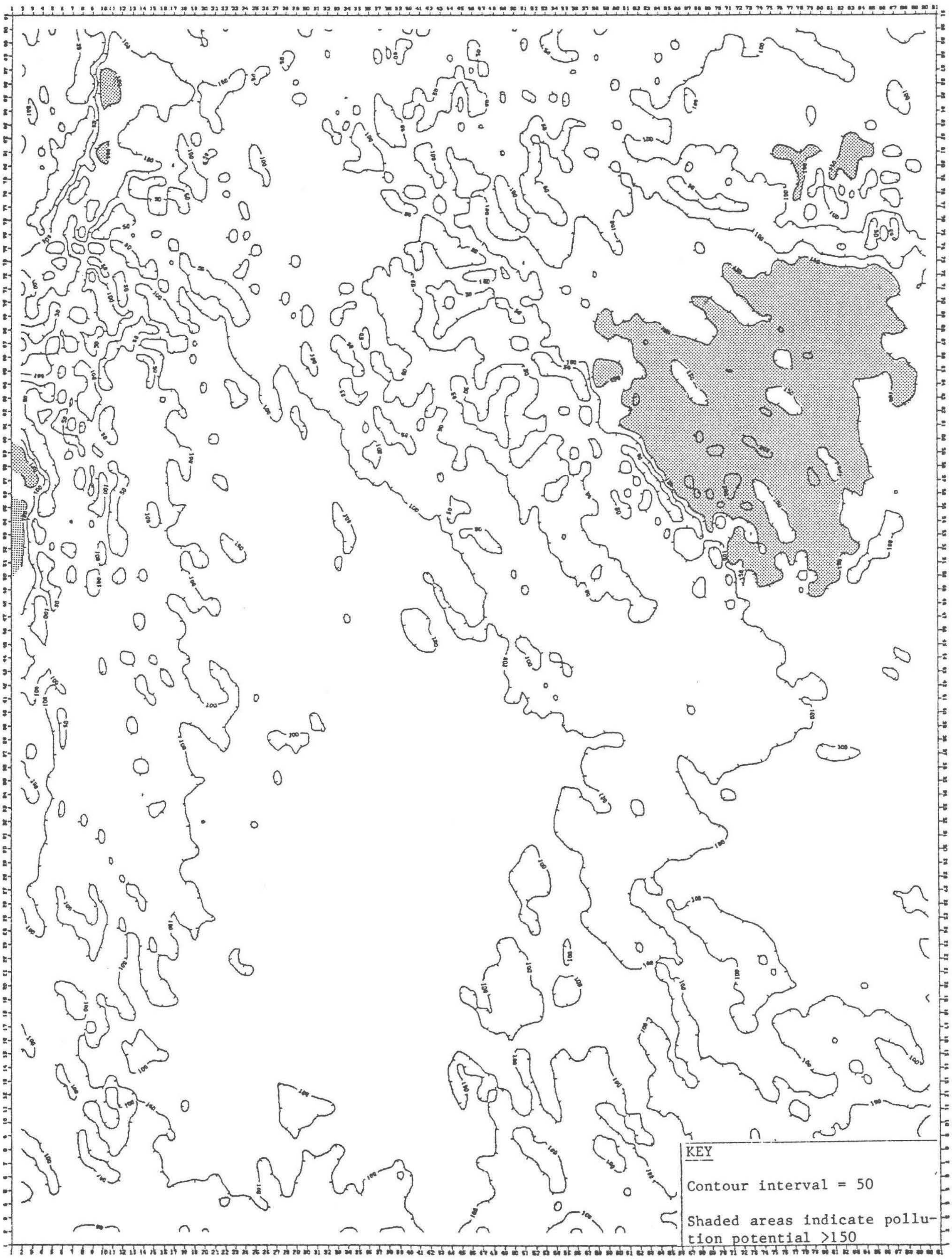

KEY
Contour interval = 50
Shaded areas indicate pollution potential >150

Figure 3-6. Pollution Potential Index Contour Map for the Southwestern Wyoming Regional Study Area Under E-Stability Conditions (occurring 16.5% of the time).

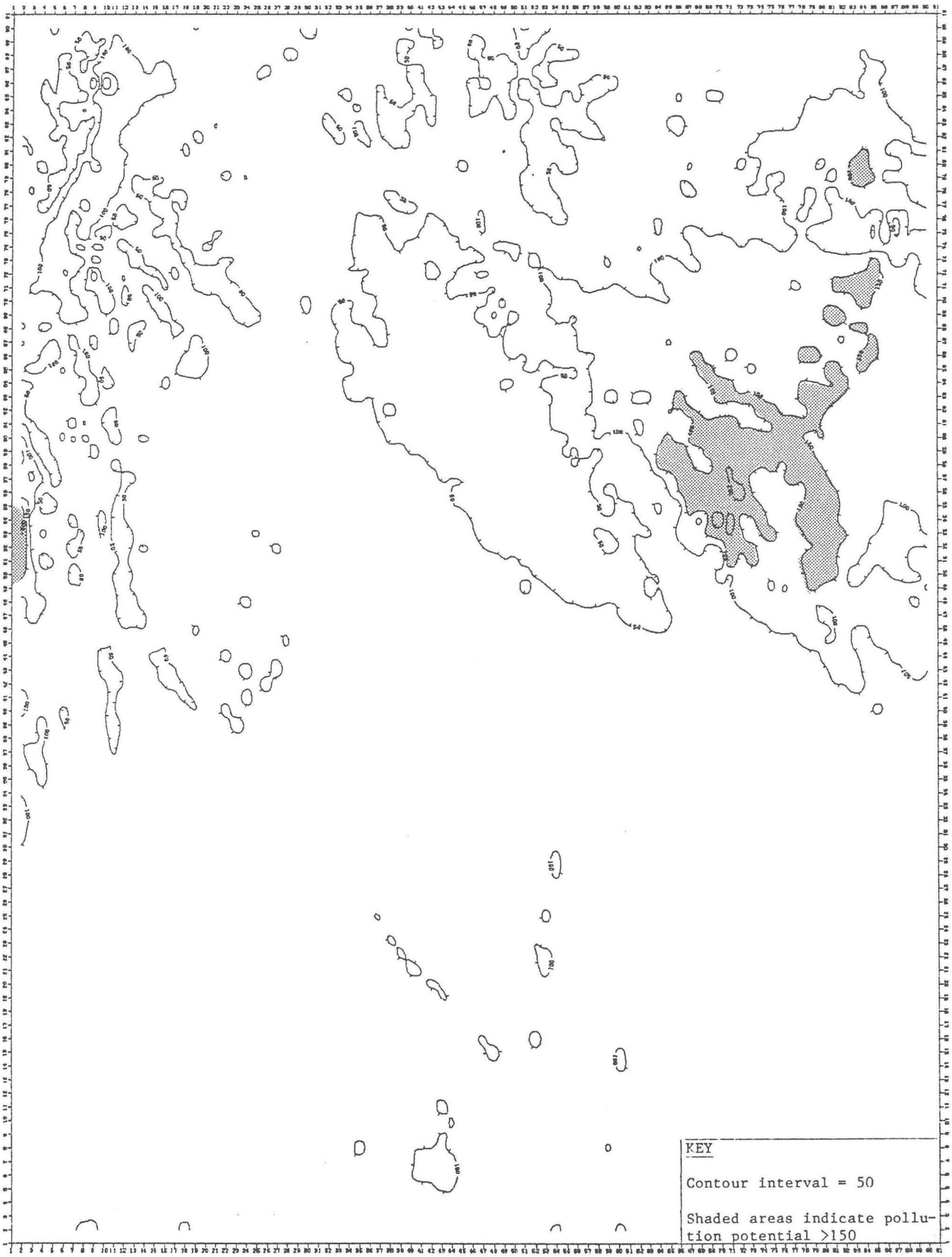

KEY
Contour interval = 50
Shaded areas indicate pollution potential >150

Figure 3-7. Pollution Potential Index Contour Map for the Southwestern Wyoming Regional Study Area Under All Stability Conditions (occurring 100% of the time).

3.3 Evanston Study Area

The primary PPI analysis for this study area was performed using stability-based wind data from Evanston, Wyoming (Layton et. al 1983). These wind data were collected by Lawrence Livermore National Labs (LLNL) during the period 12/81 to 12/82. Wind frequency distributions were available for A through F-stabilities. PPI analyses were performed individually for F-stability and E-stability wind frequency distributions. These frequency distributions are presented in Appendix A. Each frequency distribution is represented by the sixteen wind direction classes and six wind speed classes shown in Table 2-3.

WINDS/pollution potential modeling was performed for 96 wind direction /wind speed classes for each of the two considered wind frequency distributions (F-stability and E-stability conditions). The wind velocity vector results of the WINDS model for the most common wind were plotted to provide a graphic overview of the wind field throughout the study area. These two plots are provided in Appendix B.

The individual PPI values from each of the 96 model runs were proportionally combined to yield annual (stability-based) PPI representations. Annual PPI contour maps were produced for both the F-stability and E-stability conditions, and are provided as Figures 3-8 and 3-9 respectively.

The most common wind condition under both F and E stabilities is a southeast wind at 0-1.54 m/s. This is representive of worst case pollution dispersion conditions. Terrain in the area is generally oriented perpendicular to the nearly calm southeasterly flow represented by the most common E and F wind conditions. Given these circumstances, valleys would tend to be good accumulators of pollutants since the general wind flow would not readily flush pollutants from the valleys. Modeling also indicate broad areas of high PPI with some areas of very high PPIs.

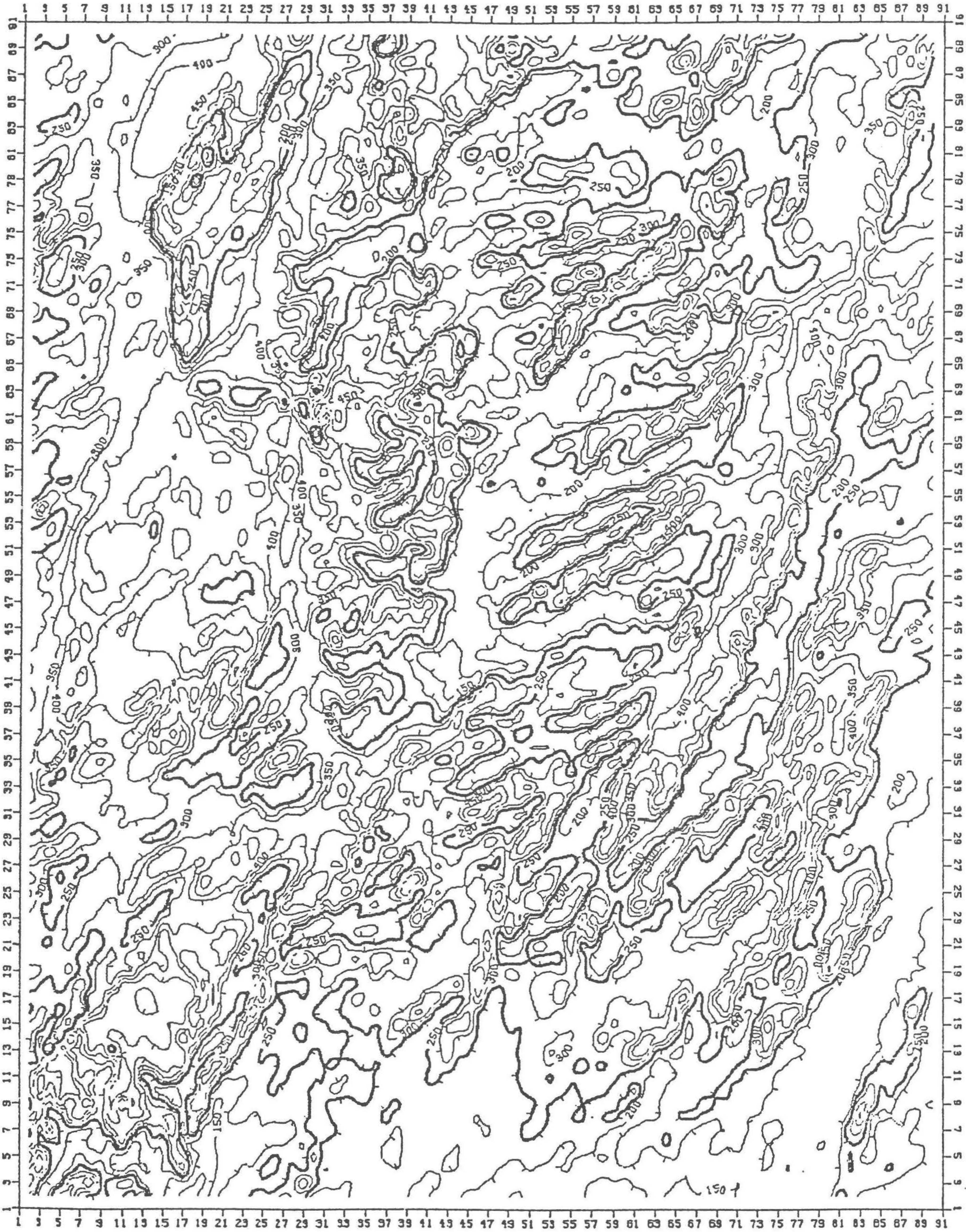

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91
300
400
350
250
200
150

Figure 3-8 . Pollution Potential Index Contour Map for the Evanston Study Area; Under F-Stability Conditions Based on Evanston Meteorological Data.

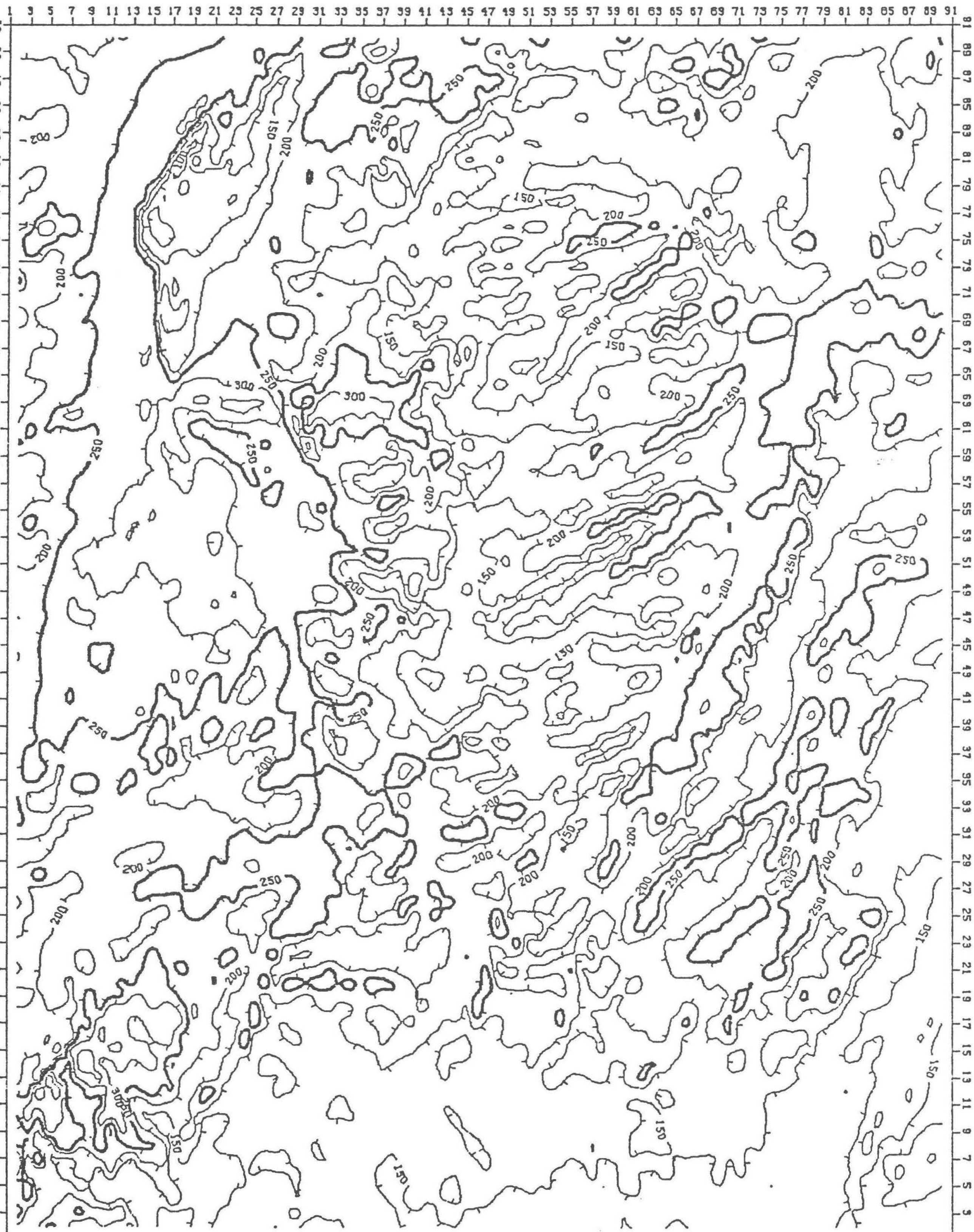

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91
150
200
250
300

Figure 3-9. Pollution Potential Index Contour Map for the Evanston Study Area; Under E-Statibility Conditions Based on Evanston Meteorological Data.

3.4 Sensitivity Analysis

As an illustration of the PPI sensitivity to specific wind data, a secondary pollution potential analysis for the Evanston Study Area was performed using stability-based wind data from the same Rock Springs, Wyoming data used in the Southwest Wyoming Regional Study Area analyses. Pollution potential index analyses were performed for F-stability and E-stability. The wind vector results of the WINDS model for the most common wind under F-stability and E-stability conditions (based on Rock Springs data) were plotted to provide a graphic overview of the wind field throughout the study area. These two plots are provided in Appendix B. Pollution potential index contour maps for F-stability and E-stability conditions, are provided in Figures 3-10 and 3-11.

The selection of the representative wind data is extremely important in evaluating the resultant pollution potential index. When Rock Springs meteorological data were used to define the most common wind under F and E stabilities (247.5° at 2.5 m/s and 270° at 4 m/s respectively), PPIs in the Evanston study area were generally medium to low. This is in contrast to the high to very-high PPI values calculated when Evanston meterological data were applied (see Figures 3-8 and 3-9). The increased wind speeds and westerly direction (which is parallel to the general topography) of the most common winds defined by the Rock Springs data resulted in good dispersion in the Evanston area. These contrasting analyses based on different meteorological scenarios were performed to illustrate the importance of the choice of meterological data when evaluating potential air quality impacts. A thorough understanding of the quality of meteorological data used in an air pollution analysis and extent to which it represents the true conditions is essential.

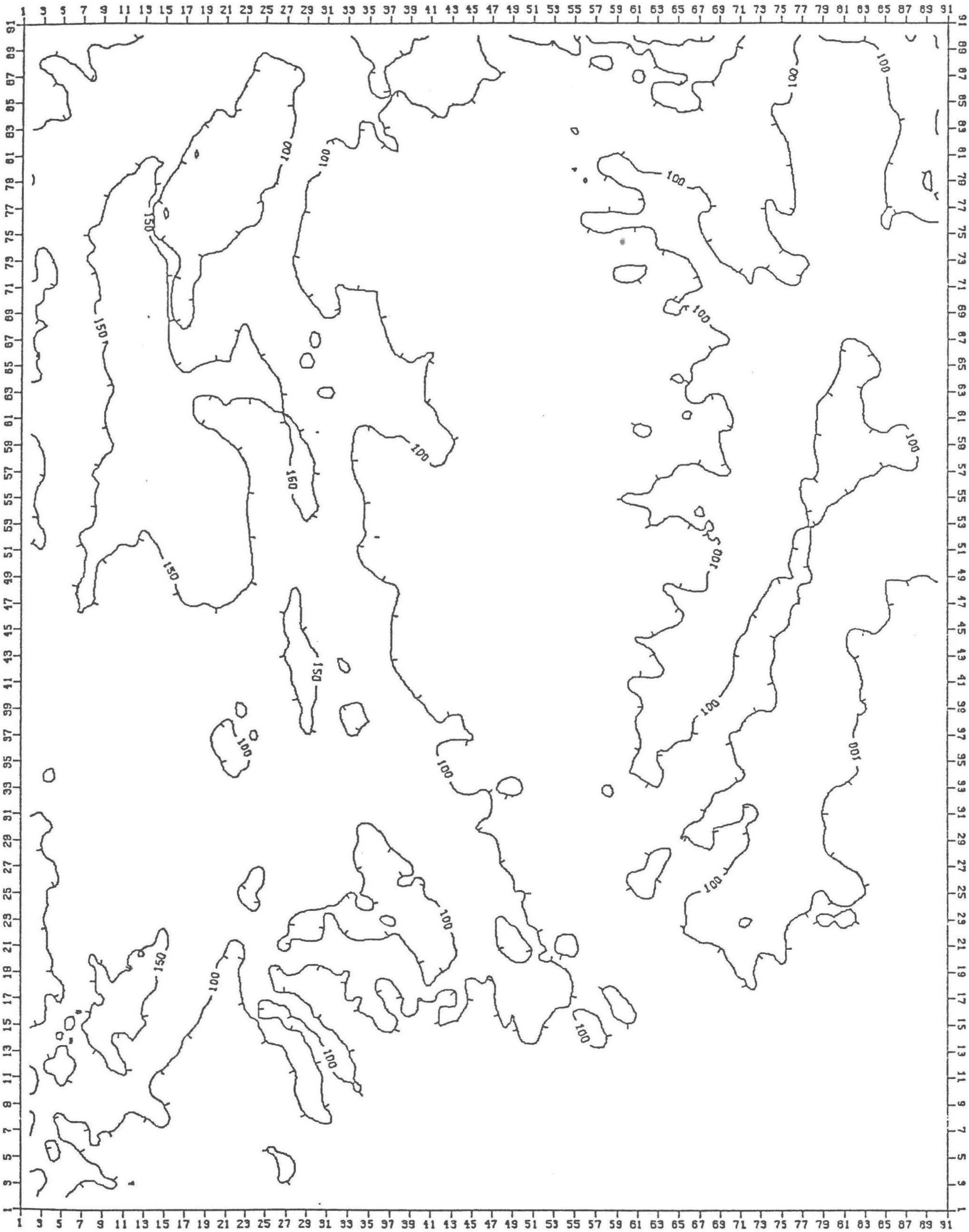

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91
100
150

Figure 3-10. Pollution Potential Index Contour Map for the Evanston Study Area; Under F-Stability Conditions Based on Rock Springs Meteorological Data.

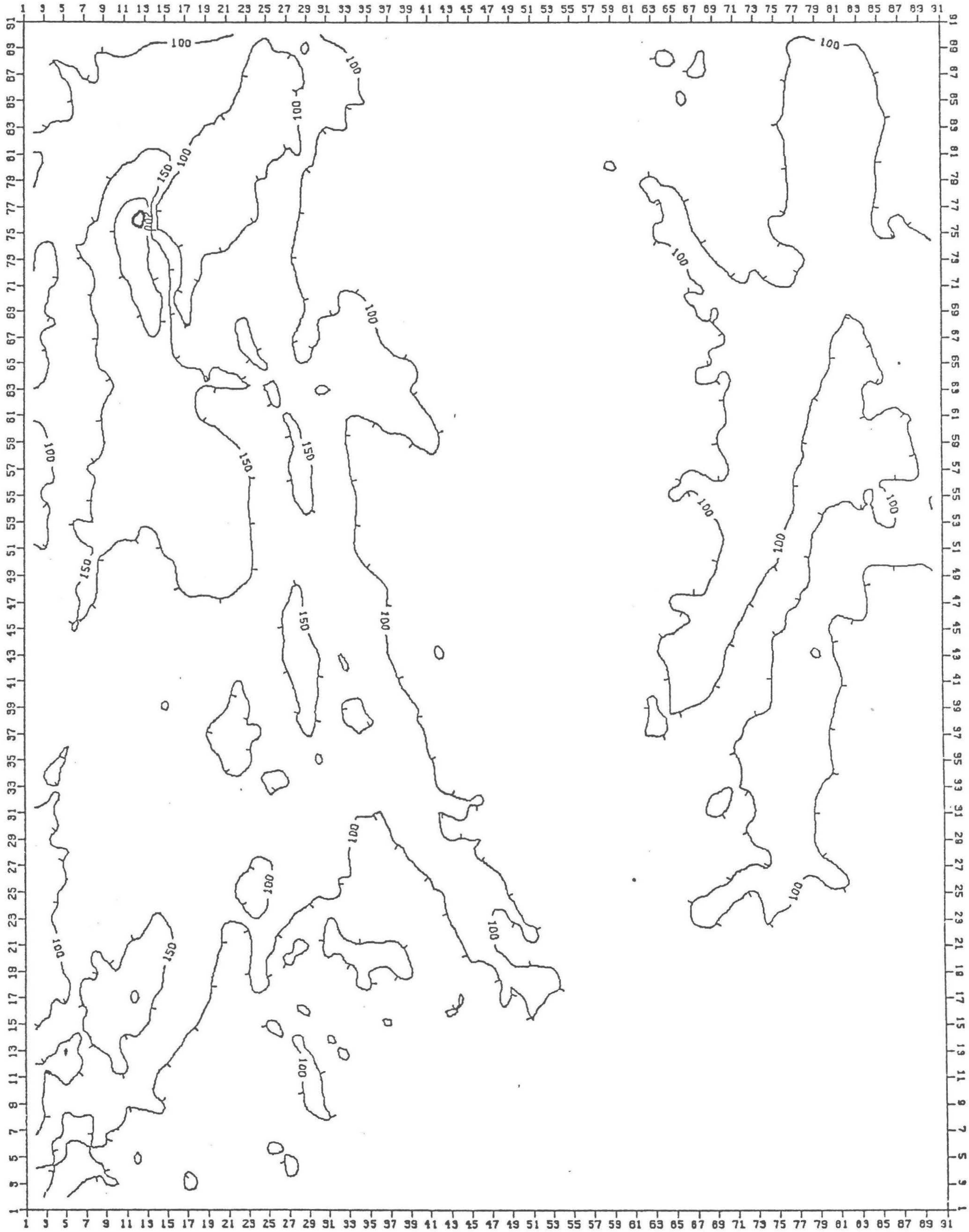

100
150
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91

Figure 3-11. Pollution Potential Index Contour Map for the Evanston Study Area; Under E-Stability Conditions Based on Rock Springs Meteorological Data.

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Layton D. W., R. T. Gelarwall, Y. E. Ricker, J. H. Shinn, K. D. O'Bannion. 1983. Accidental Releases of Sour Gas From Wells and Collection Pipelines in the Overthrust Belt: Calculating and Assessing Potential Health and Environmental Risks. Lawrence Livermore National Laboratory UCRL - 35411; UC-92a.

APPENDIX A

Wind Frequency Distributions from Rock Springs and Evanston Wyoming

A.1 Stability Based Annual Wind Frequency Distributions from Rock Springs, Wyoming (1/1/67 - 12/31/71)

ANNUAL RELATIVE FREQUENCY DISTRIBUTION STATION =24027 ROCK SPRINGS WYO 67-71 8OBS

SPEED(KTS)

DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.000000	0.002809	0.001370	0.000000	0.000000	0.000000	0.004180
NNE	0.000000	0.001919	0.000685	0.000000	0.000000	0.000000	0.002604
NE	0.000000	0.003152	0.001302	0.000000	0.000000	0.000000	0.004454
ENE	0.000000	0.001645	0.004317	0.000000	0.000000	0.000000	0.005961
E	0.000000	0.002124	0.007126	0.000000	0.000000	0.000000	0.009250
ESE	0.000000	0.001850	0.003495	0.000000	0.000000	0.000000	0.005345
SE	0.000000	0.002672	0.004317	0.000000	0.000000	0.000000	0.006989
SSE	0.000000	0.002878	0.002535	0.000000	0.000000	0.000000	0.005413
S	0.000000	0.004248	0.005961	0.000000	0.000000	0.000000	0.010210
SSW	0.000000	0.004248	0.003769	0.000000	0.000000	0.000000	0.008017
SW	0.000000	0.003700	0.009662	0.000000	0.000000	0.000000	0.013362
WSW	0.000000	0.007743	0.020145	0.000000	0.000000	0.000000	0.027888
W	0.000000	0.005893	0.021173	0.000000	0.000000	0.000000	0.027066
WNW	0.000000	0.002878	0.008017	0.000000	0.000000	0.000000	0.010895
NW	0.000000	0.001576	0.003221	0.000000	0.000000	0.000000	0.004796
NNW	0.000000	0.000891	0.001233	0.000000	0.000000	0.000000	0.002124
TOTAL	0.000000	0.050226	0.098328	0.000000	0.000000	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF E STABILITY = 0.148554

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH E STABILITY = 0.000000

ANNUAL RELATIVE FREQUENCY DISTRIBUTION STATION =24027 ROCK SPRINGS WYO 67-71 8OBS

			SPEED(KTS)				
DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.002670	0.002878	0.000000	0.000000	0.000000	0.000000	0.005547
NNE	0.001899	0.001302	0.000000	0.000000	0.000000	0.000000	0.003200
NE	0.003219	0.003289	0.000000	0.000000	0.000000	0.000000	0.006508
ENE	0.003501	0.004180	0.000000	0.000000	0.000000	0.000000	0.007681
E	0.004836	0.005619	0.000000	0.000000	0.000000	0.000000	0.010455
ESE	0.004103	0.004111	0.000000	0.000000	0.000000	0.000000	0.008214
SE	0.004302	0.004659	0.000000	0.000000	0.000000	0.000000	0.008961
SSE	0.003371	0.003563	0.000000	0.000000	0.000000	0.000000	0.006934
S	0.008094	0.009936	0.000000	0.000000	0.000000	0.000000	0.018029
SSW	0.005721	0.006441	0.000000	0.000000	0.000000	0.000000	0.012162
SW	0.005570	0.008086	0.000000	0.000000	0.000000	0.000000	0.013655
WSW	0.010414	0.013910	0.000000	0.000000	0.000000	0.000000	0.024323
W	0.009361	0.012402	0.000000	0.000000	0.000000	0.000000	0.021763
WNW	0.003746	0.005002	0.000000	0.000000	0.000000	0.000000	0.008748
NW	0.002639	0.003015	0.000000	0.000000	0.000000	0.000000	0.005654
NNW	0.002067	0.001987	0.000000	0.000000	0.000000	0.000000	0.004054
TOTAL	0.075510	0.090379	0.000000	0.000000	0.000000	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF F STABILITY = 0.165890

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH F STABILITY = 0.059339

ANNUAL RELATIVE FREQUENCY DISTRIBUTION STATION =24027 ROCK SPRINGS WYO 67-71 8OBS

	SPEED(KTS)						
DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.006280	0.011237	0.006647	0.002398	0.001165	0.000069	0.027796
NNE	0.004346	0.007880	0.003632	0.001096	0.000206	0.000000	0.017160
NE	0.006530	0.011991	0.005550	0.003974	0.002193	0.001507	0.031746
ENE	0.005413	0.011375	0.014321	0.014664	0.008223	0.002261	0.056256
E	0.007213	0.013225	0.017864	0.008839	0.002467	0.000274	0.049902
ESE	0.005370	0.009593	0.008908	0.002604	0.000343	0.000000	0.026817
SE	0.005825	0.010415	0.010210	0.001987	0.000137	0.000137	0.028711
SSE	0.004982	0.010073	0.006784	0.004043	0.000548	0.000137	0.026566
S	0.011216	0.021995	0.016719	0.008086	0.003974	0.001645	0.063634
SSW	0.007895	0.015006	0.013430	0.007880	0.004248	0.001713	0.050172
SW	0.008140	0.019049	0.026449	0.010963	0.003769	0.000754	0.069124
WSW	0.014532	0.032548	0.052556	0.033918	0.010004	0.003015	0.146572
W	0.013644	0.031246	0.066945	0.081540	0.040633	0.009593	0.243601
WNW	0.008051	0.017404	0.029259	0.027820	0.016445	0.004317	0.103296
NW	0.004481	0.009387	0.011375	0.008497	0.004043	0.001439	0.039221
NNW	0.003390	0.006372	0.005756	0.002809	0.000959	0.000137	0.019424
TOTAL	0.117308	0.238796	0.296423	0.221118	0.099356	0.026997	

TOTAL RELATIVE FREQUENCY OF OBSERVATIONS = 1.000000

TOTAL RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE = 0.088667

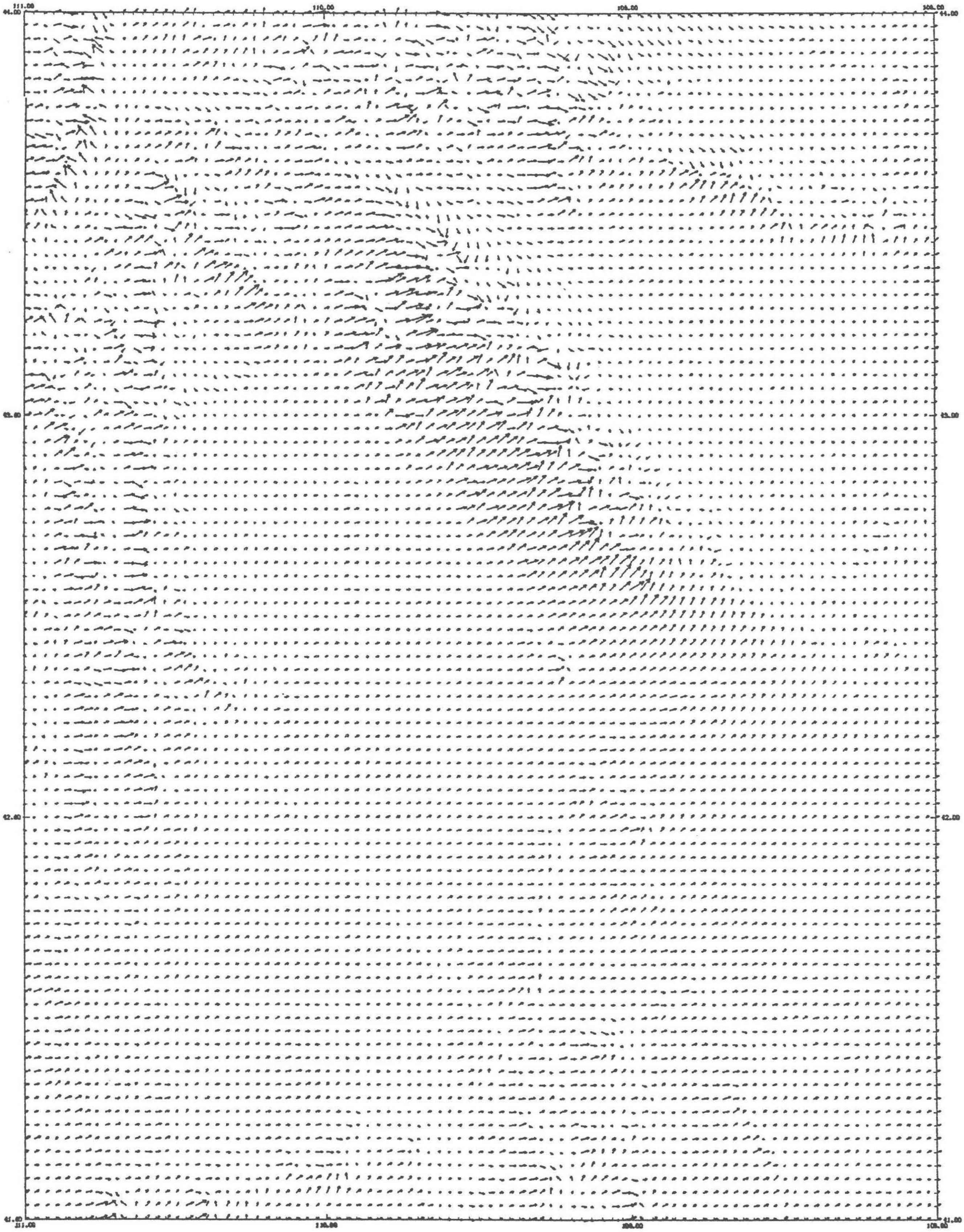
A.2 Stability Based Annual Wind Frequency Distributions from Evanston Wyoming (Layton et. al. 1983)

Stability class	Wind direction	Wind speed class					
		1	2	3	4	5	6
F	N	0.001930	0.000121	0.000000	0.000000	0.000000	0.000000
	NNE	0.002292	0.000000	0.000000	0.000000	0.000000	0.000000
	NE	0.001809	0.000000	0.000000	0.000000	0.000000	0.000000
	ENE	0.001930	0.000603	0.000000	0.000121	0.000000	0.000000
	E	0.018818	0.003257	0.000121	0.000603	0.000000	0.000000
	ESE	0.052955	0.003981	0.000121	0.000000	0.000000	0.000000
	SE	0.096140	0.004343	0.000000	0.000000	0.000000	0.000000
	SSE	0.048251	0.003136	0.000000	0.000000	0.000000	0.000000
	S	0.031966	0.002051	0.000000	0.000000	0.000000	0.000000
	SSW	0.021834	0.002533	0.000965	0.000121	0.000000	0.000000
	SW	0.011821	0.002895	0.004825	0.001206	0.000844	0.000000
	WSW	0.007479	0.001086	0.000362	0.000844	0.000362	0.000000
	W	0.005549	0.001930	0.000000	0.000000	0.000000	0.000000
	WNW	0.006393	0.000603	0.000000	0.000000	0.000000	0.000000
	NW	0.004101	0.000724	0.000000	0.000000	0.000000	0.000000
	NNW	0.003257	0.000724	0.000000	0.000000	0.000000	0.000000
E	N	0.000241	0.000603	0.000000	0.000000	0.000000	0.000000
	NNE	0.000362	0.000241	0.000000	0.000000	0.000000	0.000000
	NE	0.000483	0.000241	0.000000	0.000000	0.000000	0.000000
	ENE	0.001086	0.000844	0.000000	0.000000	0.000000	0.000000
	E	0.002533	0.001809	0.001086	0.000121	0.000000	0.000000
	ESE	0.004463	0.005308	0.001689	0.000121	0.000000	0.000000
	SE	0.018094	0.005790	0.001206	0.000000	0.000000	0.000000
	SSE	0.013631	0.004825	0.000121	0.000000	0.000000	0.000000
	S	0.009891	0.009168	0.001448	0.000000	0.000000	0.000000
	SSW	0.007961	0.010374	0.002292	0.000121	0.000000	0.000000
	SW	0.005066	0.007961	0.002292	0.002051	0.000362	0.000000
	WSW	0.002292	0.009409	0.002654	0.001206	0.000241	0.000000
	W	0.001448	0.006634	0.001689	0.000121	0.000000	0.000000
	WNW	0.001448	0.003498	0.000724	0.000000	0.000000	0.000000
	NW	0.001086	0.003136	0.000000	0.000121	0.000000	0.000000
	NNW	0.000724	0.003257	0.000362	0.000000	0.000000	0.000000

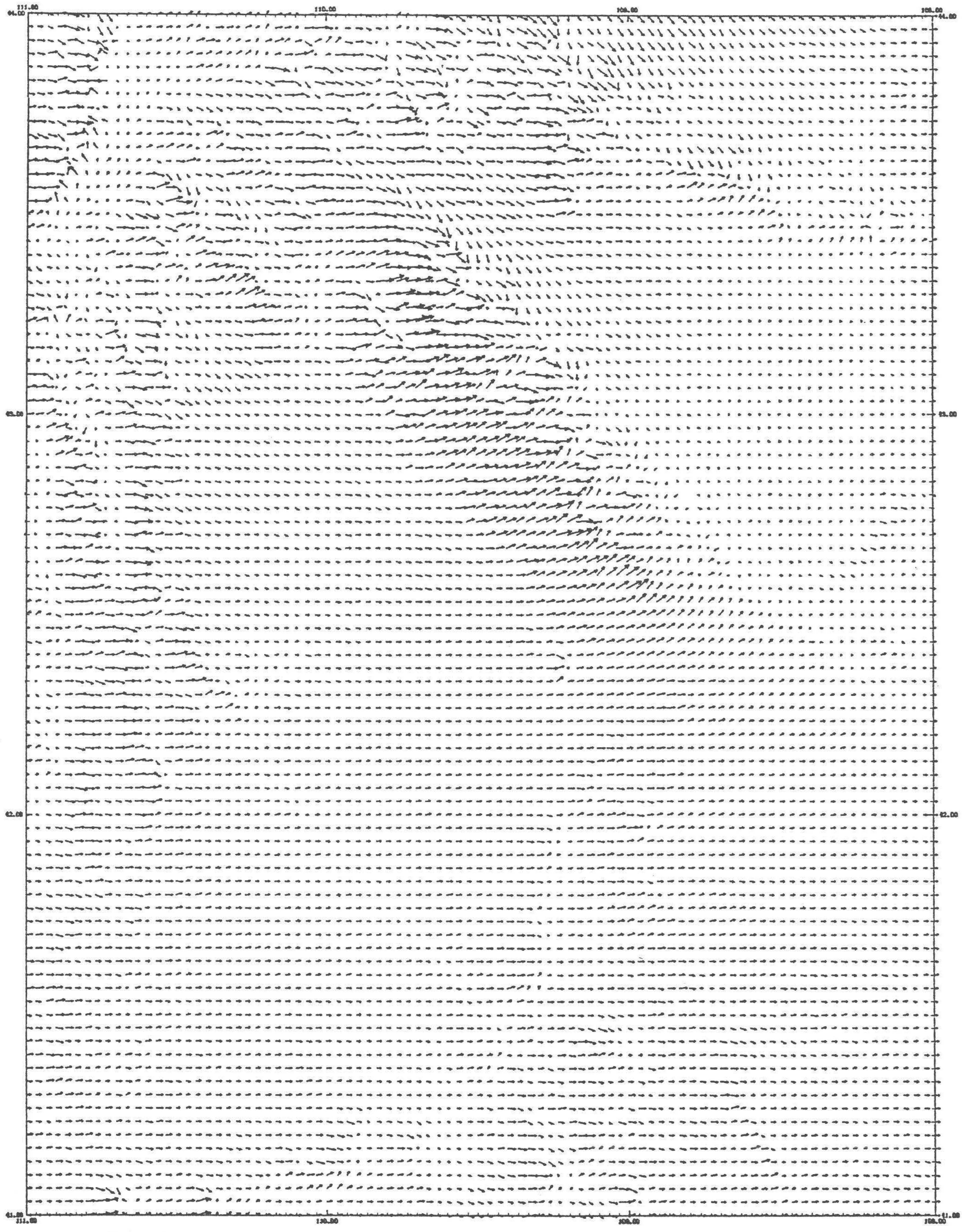
APPENDIX B

Most Common Wind Velocity Vector Plots as Generated by the WINDS Model.

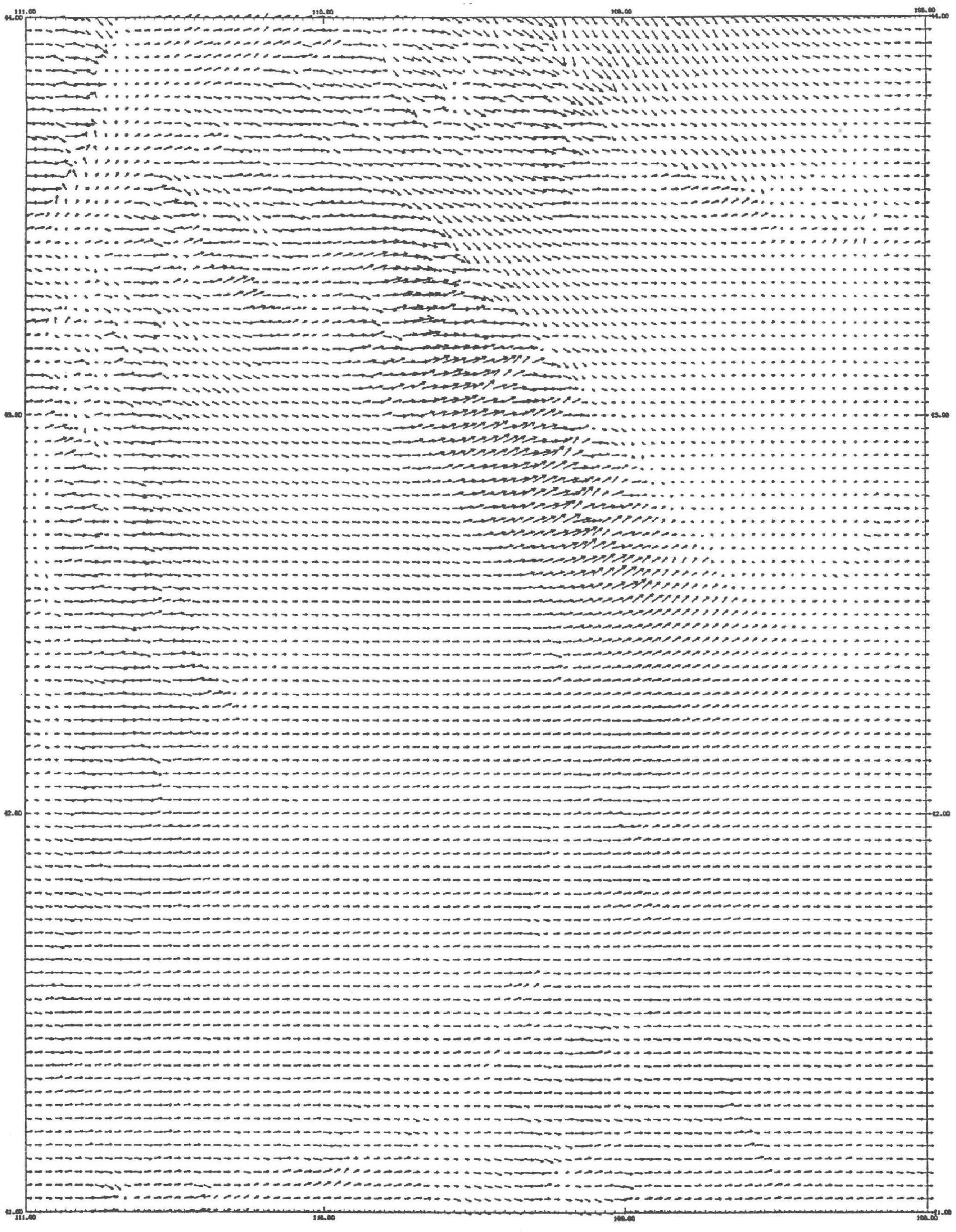
B.1 Most Common wind Velocity Vector Plots for the Southwest Wyoming Regional Study Area; based on Rock Springs Data


111.00
110.00
109.00
108.00
44.00
43.00
42.00
41.00

Velocity Vector Plot for the Most Common Wind under F-Stability (2.06 - 3.09 m/s - 247.5°) - Southwest Wyoming Regional Study Area



Velocity Vector Plot for the Most Common Wind under E-Stability (3.6 - 5.15 m/s - 270°) - Southwest Wyoming Regional Study Area


111.00
110.00
109.00
108.00
44.00
43.00
42.00
41.00

Velocity Vector Plot for the Most common Wind under All Stabilities (5.66 - 8.24 m/s - 270°) - Southwest Wyoming Regional Study Area

B.2 Most Common Wind Velocity Vector Plots for the Evanston Study Area; Based on Lawrence Livermore National Labs (LLNL) data (Layton et.al. 1983)

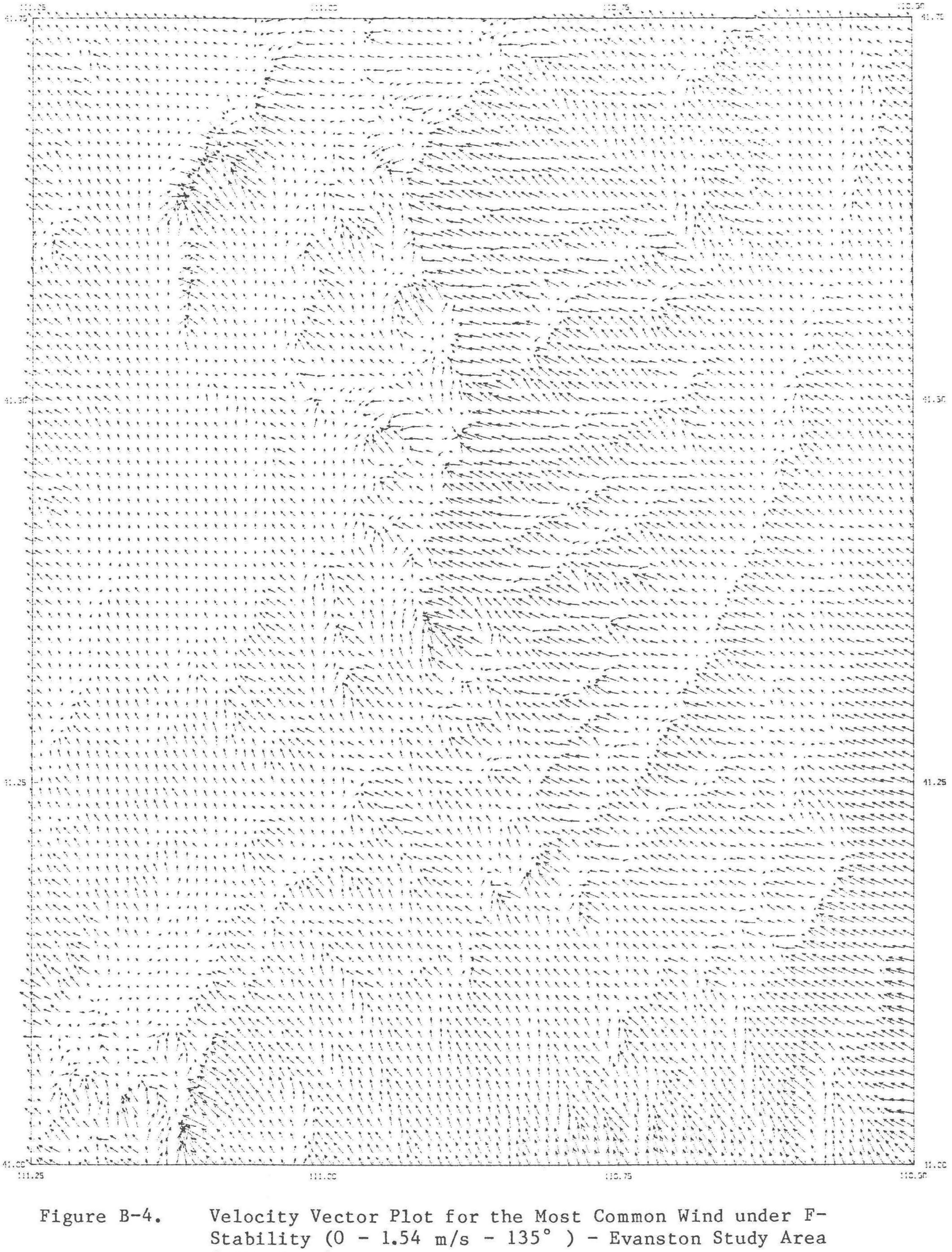


Figure B-4. Velocity Vector Plot for the Most Common Wind under F-Stability (0 - 1.54 m/s - 135°) - Evanston Study Area (LLNL Data)

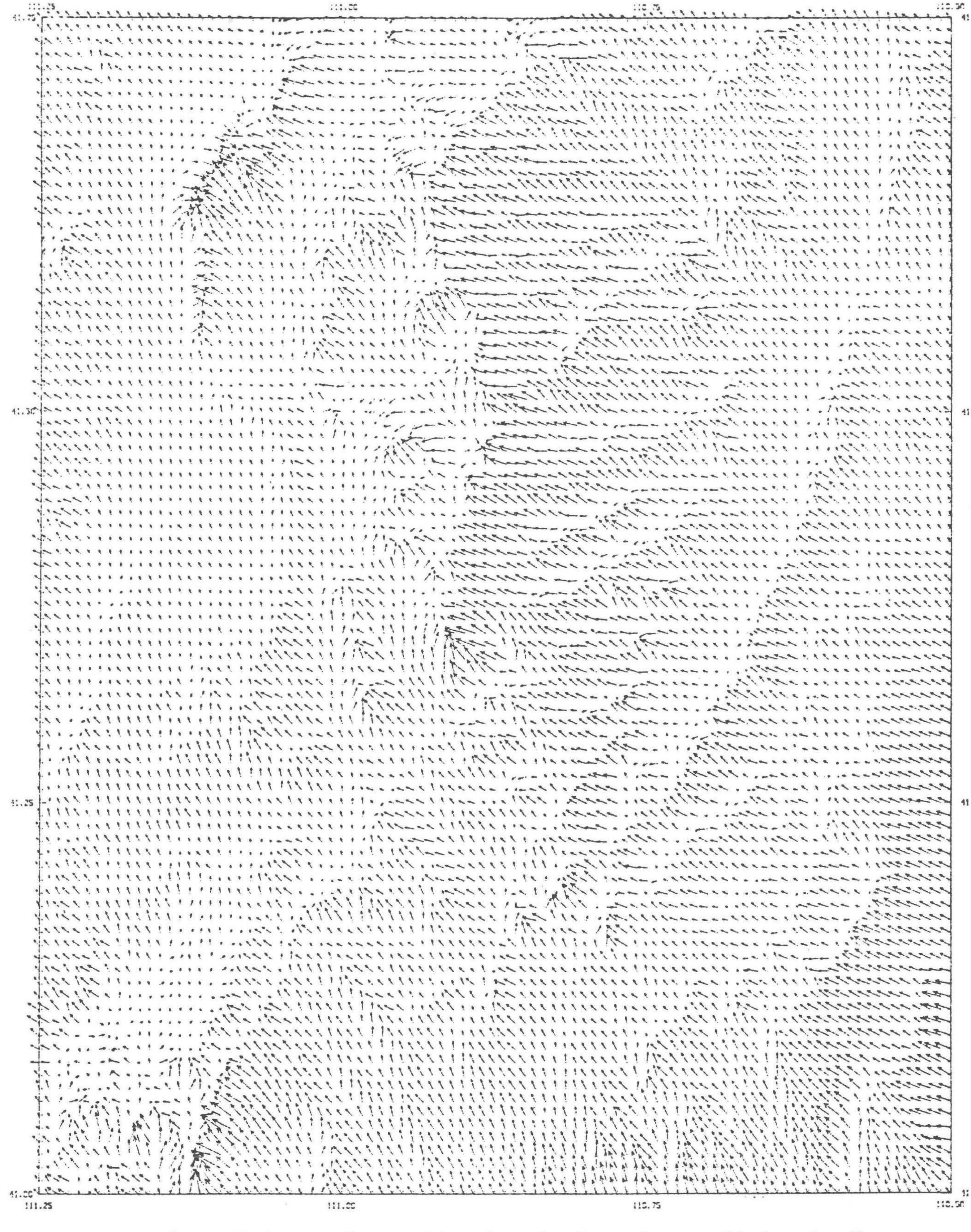

111.25
111.00
110.75
110.50
41.75
41.50
41.25
41.00
41.75
41.50
41.25
41.00
111.25
111.00
110.75
110.50

Figure B-5. Velocity Vector Plot for the Most Common Wind under E-Stability (0 - 1.54 m/s - 135°) - Evanston Study Area (LLNL Data)

B.3 Most Common Wind Velocity Vector Plots for the Evanston Study Area; Based on Rock Springs Data

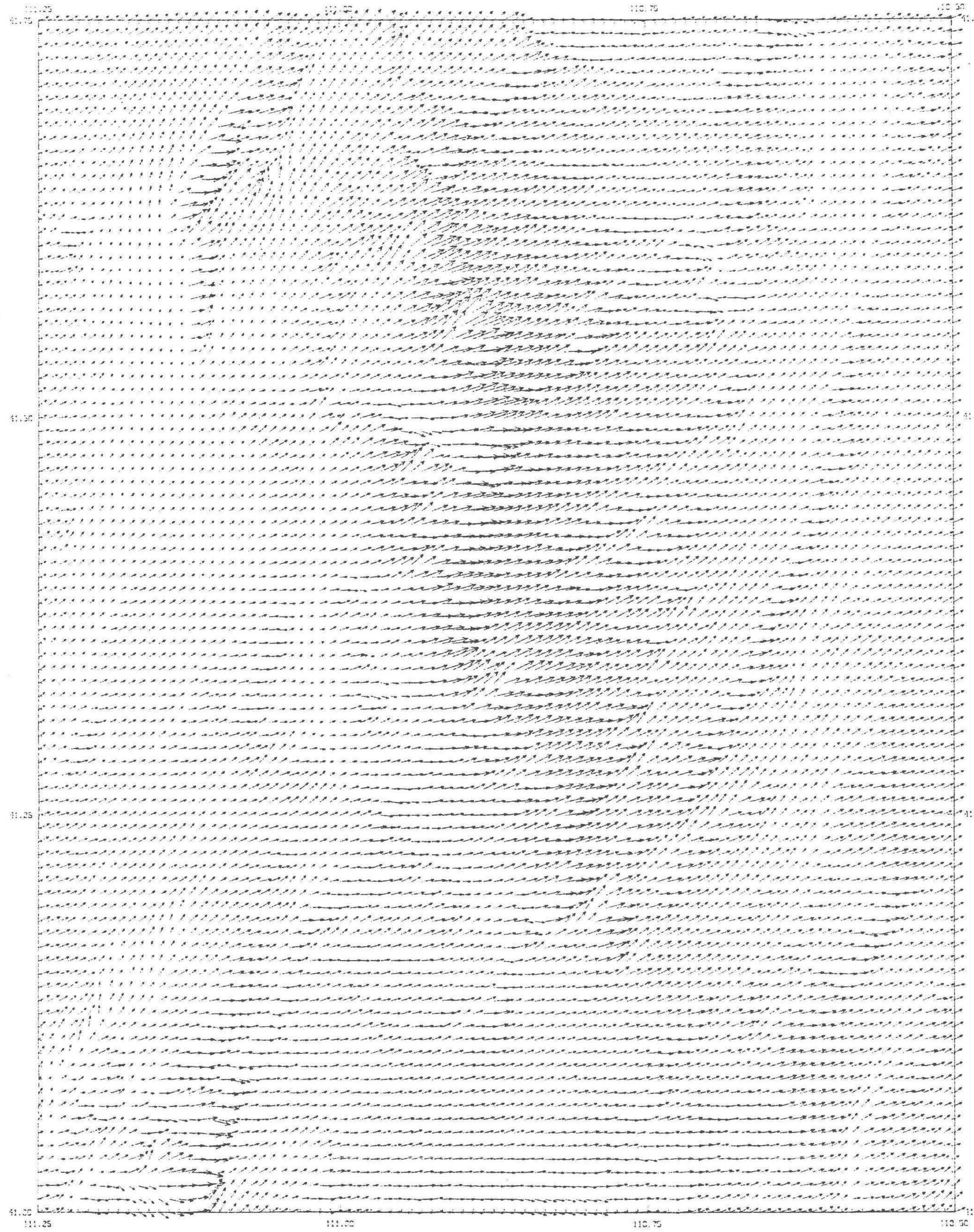


Figure B-6. Velocity Vector Plot for the Most Common Wind under F-Stability (2.06 - 3.09 m/s - 247.5°) - Evanston Study Area (Rock Springs Data)

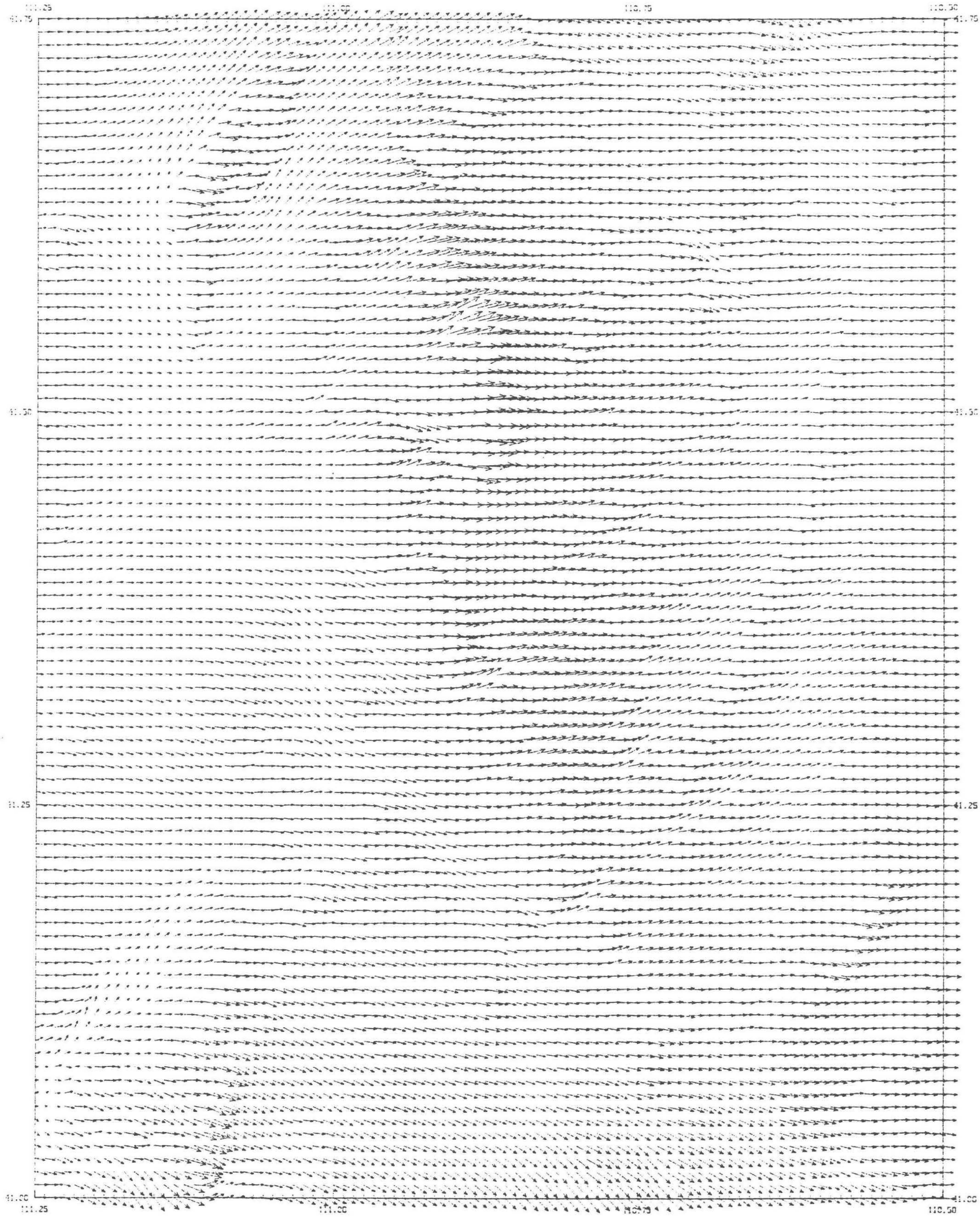


Figure B-7. Velocity Vector Plot for the Most Common Wind under E-
(Rock Springs Data)

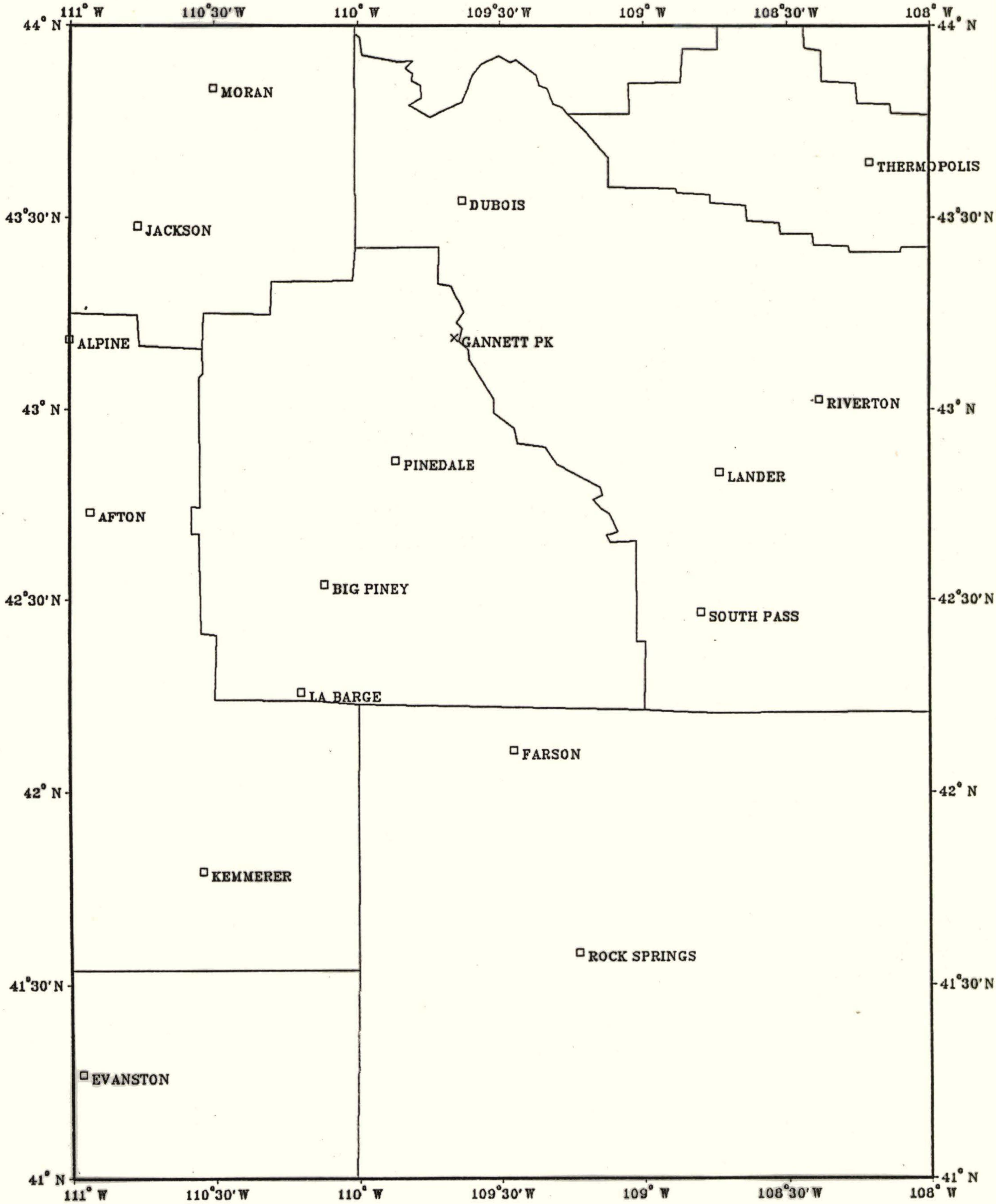

111° W
110°30′ W
110° W
109°30′ W
109° W
108°30′ W
108° W
44° N
43°30′ N
43° N
42°30′ N
42° N
41°30′ N
41° N
MORAN
JACKSON
DUBOIS
THERMOPOLIS
ALPINE
GANNETT PK
RIVERTON
PINEDALE
LANDER
AFTON
BIG PINEY
SOUTH PASS
LA BARGE
FARSON
KEMMERER
ROCK SPRINGS
EVANSTON

Plate 1. Base Map of the Southwestern Wyoming Regional Study Area.

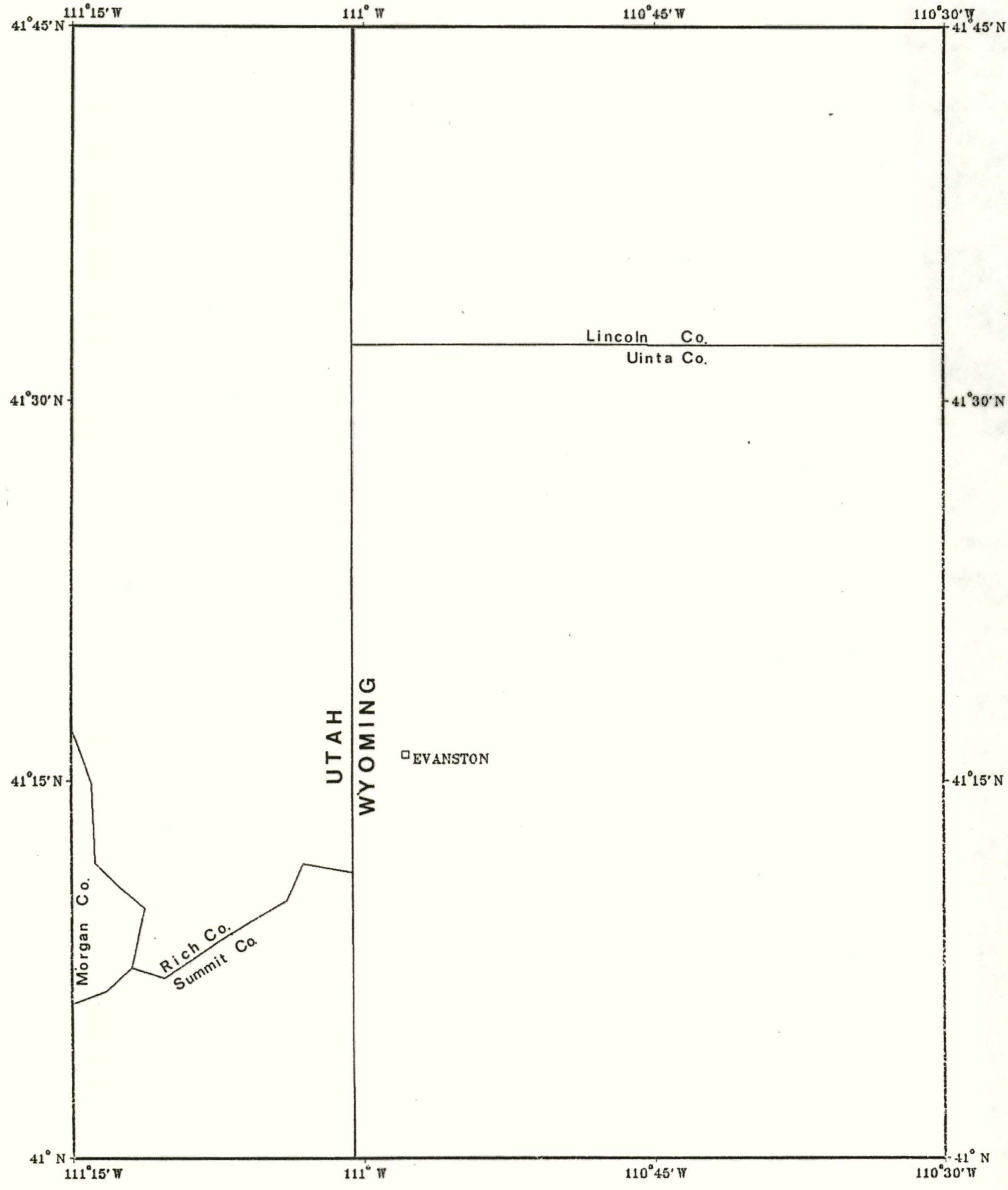

111°15'W
111° W
110°45'W
110°30'W
41°45'N
41°30'N
41°15'N
41° N
Lincoln Co.
Uinta Co.
UTAH
WYOMING
EVANSTON
Morgan Co.
Rich Co.
Summit Co.

Plate 3. Base Map of the Evanston Study Area

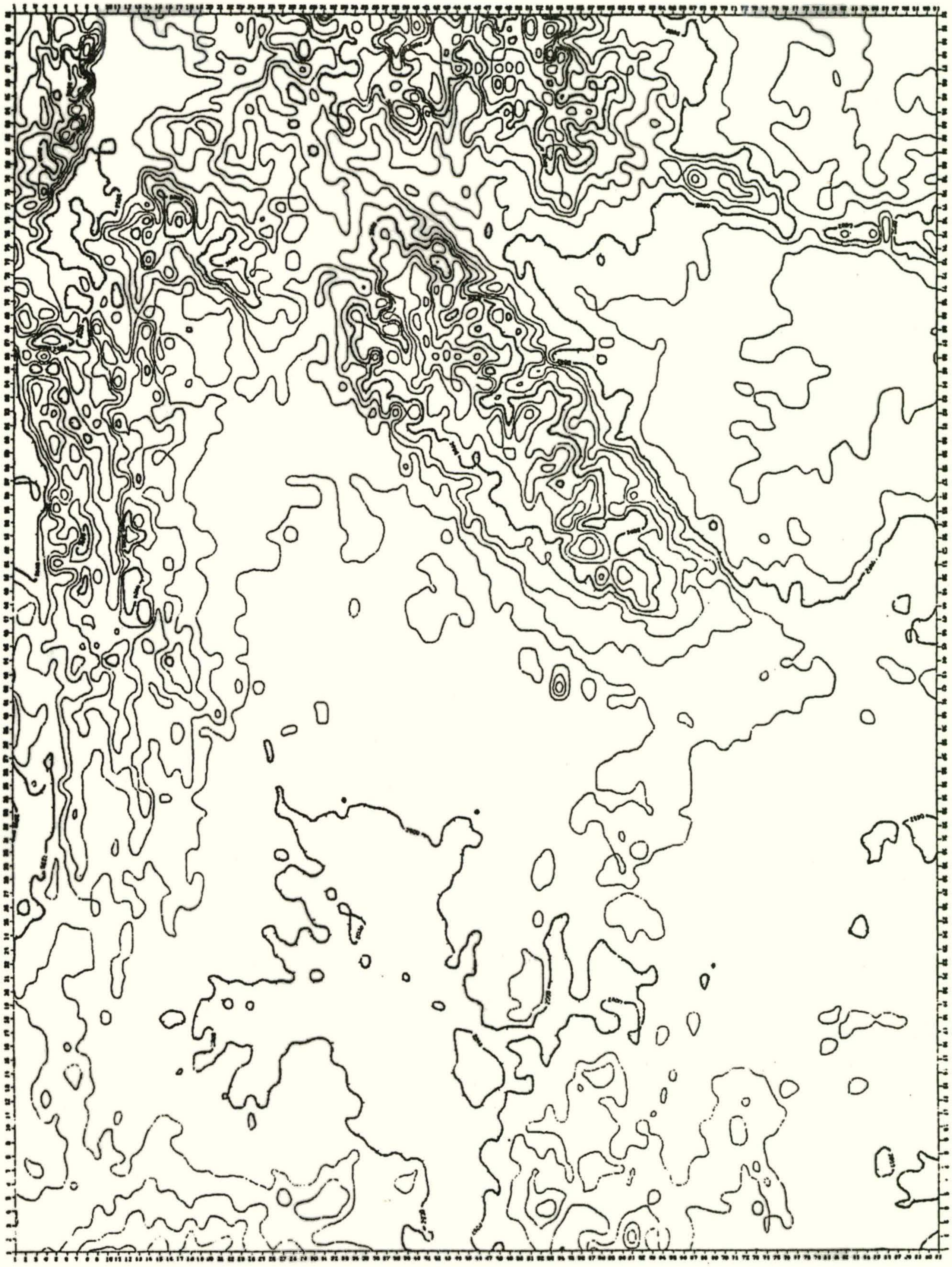


Plate 2. Topographic Contour Map of the Southwestern Wyoming Regional Study Area (Contour Interval = 200m).

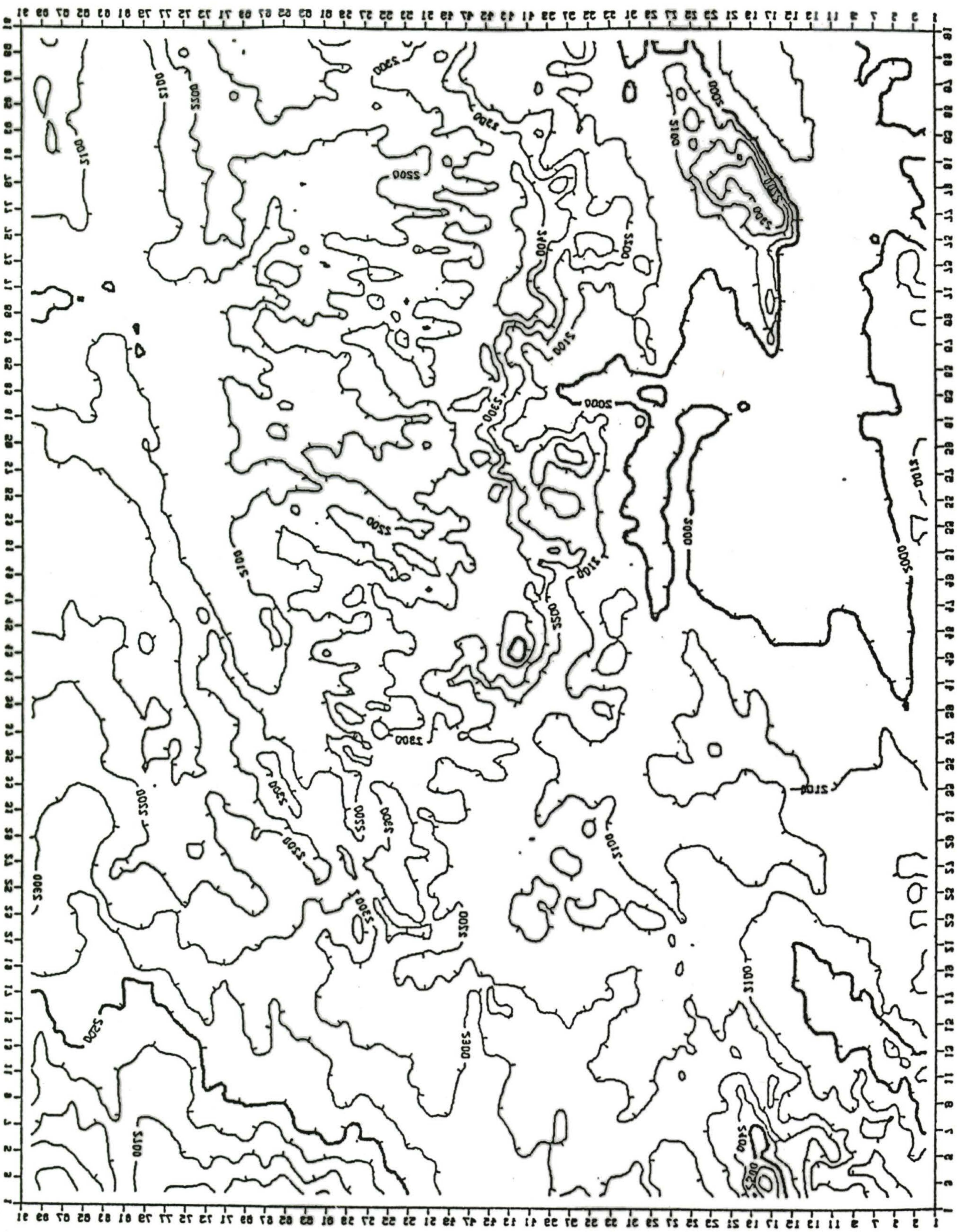

2000
2100
2200
2300
2400
2500

Plate 4. Topographic Contour Map of the Evanston Study Area (Contour Interval = 100m).